SCIENCE

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CONTENTS

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THE INTERDEPENDENCE OF FOREST CONSERVATION AND FORESTRY EDUCATION

The economic and industrial development of the western continent is comparatively recent. The abundance of the natural resources in the new world made the consideration of their exhaustion a subject of little public interest. The increasing rapidity in the depletion of these resources, particularly in the most populous and best industrially developed of the American republics, has within recent years emphasized the need of foresight in dealing with them.

The United States has been the foremost of the western nations in urging the conservation of national resources through better use and in enacting national and state laws regulating use. When a nation is new and sparsely populated the necessary encouragement for industrial expansion and increased population makes governmental regulation of forest and other natural resources less essential. There comes a time, however, in the life of every nation when future needs must be safeguarded from present private greed. When this time comes a change must be initiated in the method of handling these resources.

The recognition of this principle caused the United States in 1891 radically to change her policy regarding the unoccupied national domain and begin the establishment and organization of national forests. Prior to this time practically all of the forests in the entire country could be exploited without regard for a second crop, because nearly all timberland was

privately owned or else in the public domain open to sale or settlement. Fortunately, in the United States, when the policy of the public ownership of forest property was accepted, there were still large areas of public domain covered with timber from which national forests could be segregated without cost to the republic. Unfortunately these areas were chiefly in the western half of the country, consequently the national forests are, for the most part, located in the states west of the Mississippi River and remote from the best timber markets.

It is invariably the case that nations do not awaken to the need for forest conservation until too late to attain the best results without large expenditures of time and money. Thus, the United States in order to secure national forests in the eastern half of the country, where there is the greatest need for forest conservation and the orderly development of forest property, is forced to purchase from private owners timberland that never should have passed from public ownership.

The segregation of the national forests from the public domain during the past two decades has given us 162 national forests, having a total area of nearly 165 million acres. The more recent policy of purchasing timberland from private owners for national forests in the east has already resulted in the acquiring of nearly 386,000 acres in seven of the eastern states. About 900,000 acres additional have been approved for purchase. The fixed policy of the government relating to the management of the vast acreage in national forests is conservation through use, *i. e.*, the treatment of the property so that the yield will increase rather than decrease with use.

During the same period that the national government has been creating, organizing and developing national forests the state governments have been creating, organizing and developing state forests. At the present time, 14 states have a total of 147 state forests, which embrace an area of nearly 3,675,000 acres. New York with two large state forests of 1,825,882 acres leads all other states in the extent of her state-owned forests. Pennsylvania with 50 state forests of nearly 1,000,000 acres has done much more than the other states in the organization and development of them.

Counties, cities and towns have secured, chiefly within the past decade, communal forests varying from less than 100 acres in extent to more than 20,000 acres. Complete data relating to communal forests in the United States is not available. The states having the largest number of such forests are Massachusetts and New York. It is believed that there are, at the present time, from 200,000 to 300,000 acres of communal forests in the United States. These forests have, for the most part, been acquired for the purpose of protecting the watersheds from which potable water is obtained for the use of cities and towns. They are usually located in the vicinity of large centers of population where there is a demand for all classes of forest products, thus making the practise of intensive forestry possible.

The most interesting and far-reaching movement in forestry in the United States has been this movement toward public ownership of forest property. Approximately one fifth of the total area of the forests in the United States has been made into national, state and communal forests in the space of twenty years. The public has squarely faced the issue of forest conservation and has recognized the fact that it is not possible without the public ownership of forest property. Our forest policy is firmly anchored on the rock of public ownership that our forest resources can be made to continue indefinitely and not be-

come waning resources when increased population and industrial development make their need even more important than at the present time.

Four fifths of all the forests of the country are still in private holdings. They are in small holdings attached to farms or in larger holding in non-agricultural regions. The larger holdings contain more than three fifths of all the merchantable timber in the entire country. They are in the possession of individuals or corporations that have consolidated and brought together these large holdings in comparatively recent years, often at a large initial cost. This enormous body of virgin timber, because of the large carrying charges for interest, taxes and protection, must, from necessity, be forced on the market as rapidly as possible. This accounts for the small increase in stumpage values during recent years.

The quantity of standing timber in the hands of private owners is so large, the competition for a market is so keen, and the necessity for cutting is so imperative there is little likelihood for a marked advance in stumpage for many years to come. The inevitable result of this condition is the utter inability of the owners of more than three fifths of the merchantable timber to cut their stumpage in a manner that will insure a satisfactory second crop. The practise of forestry necessarily carries with it present expenditures far beyond those incurred in forest exploitation without regard for future crops. Only a small percentage of the private forests in the United States are so favorably located in reference to market that the value of all classes of stumpage is sufficiently high to make thinnings, reproduction cuttings, plantings and other operations concerned with the production of the crop profitable. For this reason forestry is not practised by private owners of timberland except on woodlots in strictly agricultural regions and in restricted areas of New England and elsewhere where there is an excellent local market for all classes of forest products.

Although, in most cases, the private owner can ill afford the present expenditures necessary to insure future crops and *will not make them,* the public can well afford to make such expenditures, and experience shows that *they do make them.* Thus, the administration of the national forests is spending on them nearly twice the present annual receipts. The public can well afford to make present expenditures in order to insure future crops of timber *because it is not only recompensed from the timber produced, but also by the indirect value of the forest to the entire community.* We should clearly appreciate the following fundamental truth. *It is the indirect value of the forest which accrues to the public at large that makes the practise of forestry economically possible by the public before it is possible by the private individaul.* The public can and should practise forestry, while the private individual seldom can economically, and will not. I, therefore, affirm that the practise of forestry in the United States really began with the creation of public forests. Its progress will be measured by the increase in area of such forests and the rapidity with which they are organized and orderly developed.

With this brief outline of our advance toward forest conservation, I now direct your attention to the intimate relation that forestry education bears to it. Forestry education was the fountain head from which sprang the beginnings of forestry in this country. Forestry education is the source from which flows all progress in forestry. It shapes and directs our forest policy and determines our methods of prac-

tise. Forestry education and forest conservation have moved forward together. Without the one the other would be impossible.

Forestry education began in the United States more than a century ago, but not in schools. It began with the first desultory efforts of a few far-seeing enthusiasts, who had a clear vision of the future, to interest the public in forest conservation. Little progress, however, was made until the early eighties when more systematic propaganda was undertaken. A forest commissioner was appointed by the United States Department of Agriculture. The importance of this office has steadily grown. In 1886 it became the Division of Forestry, in 1901 the Bureau of Forestry, and in 1905 the Forest Service. Practically all of the early work of this branch of the government service was educational in character, viz., *systematic propaganda showing the need for forest conservation.* Great assistance in this important movement was brought about in 1882 through the formation of the American Forestry Congress, which later became the American Forestry Association. The proceedings of this society contain the complete history of the progress in establishing our present forest policy. Its journal *American Forestry* has been a leading force in shaping public opinion favorable to forest conservation. Forestry commissioners were appointed in various states in rapid succession, and state and local forestry associations were formed.

All of the above forces working together so shaped public opinion that it became possible to enact legislation in 1891 making the public ownership of forests possible. Prior to this date New York and a few other states had begun the establishment of state and communal forests, but purely for the purpose of protection, recreation and sport. Up to this time forest conservation in the United States was not in the woods. It was chiefly educational propaganda—the shaping of public opinion in the desire for forest conservation. National forests were established in rapid succession after the above date. Many states began or continued the policy of acquiring forest property for state forests; and later, here and there throughout the country, but particularly in the east, counties, cities and towns began to acquire adjacent lands for communal forests.

The establishment of public forests has gone on until at the present time approximately one fifth of the forests in the United States are public forests, to be held for the production of timber and for protective purposes. During the long period of propaganda leading to the approval of, and the desire for, the public ownership of forest property in the United States, the burden of developing public opinion favorable to forest conservation fell upon the shoulders of a small number of men who were willing to contribute their time and money toward what they believed to be a great and pressing public need. As time passed, this small group grew into a vast army and public opinion favorable to forestry was the inevitable result. It is the writer's belief that no republic can reach even the beginning of forest conservation unless some of her citizens recognize the need and are willing to sacrifice their time and money for this public necessity.

I purposely place great emphasis upon the period of educational propaganda because without it our remarkable development in forestry during the past twenty-four years would have been impossible. *A great constructive movement in forestry can not be initiated in a republic without the people solidly behind it.* Our constructive work of the past two and a half decades rests upon years of organized edu-

cational prapaganda. Our sister republics in their efforts to place forestry upon a sound foundation must build the foundation out of public desire. Organized educational propaganda in the hands of national and local forestry associations, propagandist journals, and efficient press bureaus are the great forces in creating a public opinion favorable to forest conservation. When public desire has been created the practise of forestry becomes possible. It is not possible earlier.

Although educational propaganda favorable to forestry began in the United States more than a century ago, technical training in the science and art of forestry had its beginnings within the past two decades. The first forest school of collegiate rank was established at Cornell University in 1898. Two years later a professional forest school was established at Yâle University. During the following decade and a half more than twenty schools or departments of forestry offering professional training and a degree in forestry after the completion of a prescribed course were established in various parts of the country, either as separate institutions or as departments of existing universities and colleges.

The question naturally arises, Why was technical training in forestry so long delayed and why has it met with such extraordinary expansion in the short space of seventeen years? The answer is found in the bringing of approximately 20 per cent. of all the forests of the United States under public ownership.

The establishment of public forests carried with it the necessity for their management and orderly development. This could not be attained without men trained in the science and art of forestry. The segregation of 162 national forests from the unoccupied public domain having an average area of more than 1,000,000 acres, within the space of twenty years has in itself called for the services of hundreds of technically trained men, and will call for many more men with the gradual increase in the intensity of management. The schools arose to supply this demand for trained men. There was no demand for professional schools until public ownership of forest property became the keystone in our forest policy, and there would be but little demand now were this keystone removed. Our whole structure of forest conservation, of forestry education, of forest practise rests upon the public ownership of forests. The economic situation relating to private forest property is such that, in the main, exploitation rather than forestry will be the basis for operation for many years to come. Pull down the keystone of public ownership and the splendid structure that has been erected with its great National Forest Service and the forest service of the several states will crumble, cobwebs will cover the windows of our professional forest schools, and the dark ages of forestry conservation will again prevail. The keystone must not be removed. It is believed that public opinion will not waver from the task that it has set, but will strengthen as time goes on *until at least 50 per cent. of the strictly non-agricultural lands capable of producing forest crops is publicly owned,* until at least this amount of our potential forests are back in the hands of the public who made the great economic mistake years ago in bartering them for a mess of pottage. If this optimistic view of forestry in the United States prevails, the efficiency and power of our forest schools will increase and they will gradually adjust themselves more closely than at present to the needs of the country.

The remarkable increase in agricultural research and education in the United States during the past half century has pro-

foundly influenced agricultural production. The vast sums spent annually by the nation, the states and lesser governmental units are returned a hundredfold by increased and diversified production. Our large number of agricultural colleges and experiment stations are living monuments to the public belief that the conservation of agriculture squarely rests upon the educational forces that direct and shape its progress. Our forest schools and research stations are just as essential in our scheme of education if the practise of forestry becomes a part of our national development and the future growth of forest crops adequate for our needs.

The superior position of Germany in forest conservation, whereby she produces nearly all of her wood requirements without lessening her forest capital through overcutting, is due to her many, long-established forest academies and other institutions where hundreds of young men are trained in the production and utilization of forest crops and in the principles which underlie a sound and economic forest policy. Her technical forestry education has been of slow but progressive growth, beginning with the "master schools" of Zanther, Hartig and Cotta nearly a century and a half ago. Each of these forest managers surrounded himself with young men and taught them the principles of forest practise on the forests under his charge. This early work gradually grew into the present educational system with the many forest academies and other institutions for the training of men in the science and art of forestry. The gradual development of forestry education in Germany has resulted in a healthy growth and has moved in the direction most useful for the needs of the country. A similar development of forestry education in the United States was impossible, due to the establishment of more than 165,000,000 acres of public forests in less than two decades, all awaiting organization and orderly development and for which the public was willing to pay. Hundreds of trained men were wanted at once to assume responsible positions as district chiefs, inspectors, investigators and supervisors. This call for a large number of professionally trained men at one time has resulted *in a remarkable growth in forestry education in the United States.*

Forestry education in the old world has developed around two general types of schools, viz., the university schools and the better type of forest academies, which are strictly professional in their training, and the ranger or practise schools, which are vocational in training. The former are scientific, and the preparatory and technical courses are equivalent to five or six years of collegiate work in this country. The latter are primarily concerned with the recognized art of forestry in the particular region where the men are trained to practise. The course is usually but one or two years in duration and is based upon a common school education. The men trained in the first of these two classes of schools after a year or more of apprenticeship under a practising forester are in line for gradual promotions to the highest positions which the profession has to offer. The men trained in the second are equipped for the vocation of ranger, woods foreman, and similar positions concerned with the oversight of labor in producing and harvesting the forest. The purpose of the latter school is entirely different from that of the former. Its aim is to train men for subordinate positions.

In the organization and orderly development of forest property there is need for many more men trained in the vocational schools than there is for men trained in the

professional schools. In forestry, scores of foremen, guards and rangers are necessary for every professionally trained forester. Where one man trained in the science of forestry will find a position suitable to his attainments, many men vocationally trained in the local art will find work.

A hard and fast line can not be drawn in this country between these two classes of schools, although, in the main, there has been an abnormal development of the professional schools and an underdevelopment of the vocational schools. The reason for this one-sided development of forestry education in the United States is found in the demand for professionally trained men in the decade between 1902 and 1912, which is the period during which nearly all the professional schools were established. The transfer of the national forests to the Department of Agriculture in 1904 and their organization under the Forest Service created positions for a large number of trained men. During the same period a rapidly increasing demand for professionally trained foresters was created through the establishment of departments of forestry in many states. All of these positions, with the possibility of rapid promotion, were highly attractive to college men. How rapidly the educational machinery of the country responded to this demand for technical training is shown in the number of schools now offering degrees in forestry and the facilities for technical training that are in the process of development.

The following is a list of the institutions in the United States that offer technical courses in forestry leading to a collegiate degree. This list shows the number of degrees granted by each institution prior to December, 1915, and the number of graduates actually employed in the profession in April of the same year.

Institution	No. of degrees granted prior to Dec., 1915	No. of graduates engaged in forestry, Apr., 1915
Colorado College School of Forestry	10 F.E.	
Colorado Agricultural College	1 M.F.	8
Cornell University	4 B.S.F	3
	17 F.E.	
	16 B.S.F.	
	11 M.F.	35
University of California	0	
Georgia State College of Agriculture	3 B.S.F.	—
Harvard University	53 M.F.	50
University of Idaho	8 B.S.F.	
	1 M.F.	5
Iowa State College	37 B.S.F.	25
University of Maine	50 B.S.F.	30
Michigan Agricultural College	97 B.S.F.	48
University of Michigan	103 M.S.F.	71
University of Minnesota	83 B.S.F.	
	1 M.S.	63
University of Missouri	6 B.S.F.	2
University of Montana	1 B.S.	—
University of Nebraska	60 B.S.F.	
	1 M.F.	46
Ohio State University	80 B.S.F.	47
Oregon Agricultural College	28 B.S.F.	16
Pennsylvania State College	106 B.S.F.	68
Syracuse University	31 B.S.F.	
	4 M.F.	11
State College of Washington	2 B.S.F.	—
University of Washington	23 B.S.F.	
	8 M.S.F.	22
Yale University	340 M.F.	253
Totals	1,185	803

In the space of fifteen years 1,185 men have been granted degrees in forestry in the United States. About one half of the degrees granted have been undergraduate degrees given for four years of collegiate work. Advanced degrees in forestry are offered by ten institutions. These schools have large faculties of more mature and experienced instructors and are better equipped for instruction in both the science and art of forestry.

In April, 1915, out of 1,037 men who had then received degrees, 803 were reported as actually engaged in forestry. The tremendous influence of the United States Forest Service in shaping forestry education in this country is shown in the fact that from 1899 to 1915 there were 591 forest assistants appointed to that service

through civil service examinations, as shown in the table below. Of this number 273 were appointed through competitive examinations from among the graduates of a single professional school. The position of forest assistant is the lowest technical position in the service and new appointments to this position are determined by civil service examinations.

FOREST ASSISTANTS APPOINTED IN THE U. S. FOREST SERVICE FOR THE PERIOD BETWEEN 1899 AND 1915 INCLUSIVE

1899	2	1908	52
1900	2	1909	48
1901	8	1910	73
1902	13	1911	72
1903	19	1912	72
1904	42	1913	31
1905	57	1914	26
1906	35	1915	9
1907	30		
		Total	591

The universities and colleges in the United States that offer professional training in forestry granted degrees to 147 men in June, 1915. From the number of men now attending courses in forestry in these institutions it appears that a larger number will complete their training in 1916 and a still larger number in 1917. Four years ago 72 forest assistants entered the National Forest Service under civil service appointments. Since then the number of appointments has decreased with startling rapidity. Only 9 appointments to the position of forest assistant through civil service examinations were made in 1915. From 1900 to 1910 the number of yearly appointments increased from 2 to 73. It was during this period that the many schools arose and secured equipment and faculties to supply this rapidly increasing demand for professionally trained men. Although the schools are far better equipped than formerly, the rapidly decreasing demand in the public service, due primarily to the completion of the preliminary organization of the public forests, is forcing nearly all of the graduates in forestry during 1915 to seek employment in the forests under private ownership or to find places on the public forests that are also open to those without a professional training, hoping to be promoted to better positions later on. From now onward, the annual appointment of technically trained men to new positions in forestry under the national, state and lesser governmental units depends upon the rapidity with which additional public forests are established and the subdivision of present public forests into smaller and more intensively managed units. *We can not expect in the future a demand in public forestry for men with a professional training at all commensurate with the increasing supply of such men.*

Trained foresters must be willing immediately after graduation to do the work of ordinary labor and work for the same wages as ordinary labor. They must look upon this period of their life as a period of apprenticeship. Accepting this point of view, the whole question of its desirability rests with the probability of promotion after a reasonable apprentice period has passed. In the main, it must be considered a mistake for a man who has spent from four to six years in collegiate and professional training to accept a position either in governmental or private work unless it leads towards a field that will enable him to practise his profession at a remuneration somewhat proportionate to his technical ability.

The permanent labor employed in our public forests, including the position of guards and rangers, is usually recruited from among residents of the states where the forests are located and from men wholly without technical training, but with a more or less intimate knowledge of local conditions. The examination required is not technical in character. These men are

employed in large numbers and at first are, without doubt, more useful than professionally trained men unfamiliar with the locality and conditions when employed at what is ordinarily considered guard or ranger work. From amongst this army of men without professional training, many are later promoted to the position of supervisor and to other places in the higher branches of the service. These promotions are made without further examinations. There is no doubt but that qualities that lie wholly outside of technical efficiency are of fundamental importance in the appointment to the lower places in public forestry and in later promotion. When these other qualities are acceptable, however, appointment and promotion should center upon thorough technical preparation, upon an intimate knowledge of the science of forestry which can seldom be obtained except by a series of years of systematic training. Rule-of-thumb methods picked up in the woods seldom prepare a man for justifiable promotion to positions that deal with the organization and orderly development of forest property. Were this fundamental distinction between technical training and woods experience adequately appreciated in promotion, the college man with technical training could better afford at the outset of his professional career to take his place with ax and saw by the side of his non-technical competitor.

The largest present field for men immediately after completing their professional training is in private work, but here a man must prove his worth before he is given more than a workman's wage. Although four fifths of our forests are privately owned, the economic conditions that control timber prices are such that professionally trained men can rarely be employed under adequate salary, and money can seldom be expended by private owners for the sole purpose of employing scientific methods in the production of forest crops. When employed, their work must deal with methods of better and closer utilization rather than forest production. Although this field is unlimited for professionally trained men who are willing to begin at the bottom and offers the highest financial prizes for those having the requisite qualifications, *the qualifications based upon full professional training are secondary to other more fundamental ones which combined form business efficiency and business sense.* It is bad foresight to train so many men in the scientific production of forest crops that the larger proportion are later forced into farming or various commercial callings.

Although full professional training is essential in national, state and communal forestry where present expenditures are possible through public appropriations for the organization and orderly development of the forest, I seriously question whether at present it can find adequate scope in private forestry, *because the organization and orderly development of the privately owned forest can seldom be attempted under present economic conditions.* What private forestry in the United States needs is more vocational training and less professional training. A few instead of many strong professional schools, well equipped for both teaching and research, whose graduates can find adequate scope for their attainments, *should rest upon a much broader foundation of public and vocational training in forestry* than we have at the present time. It is the duty of these schools to lead in forestry investigation, the publication of technical books on forestry, and the support of technical journals.

Agriculture and forestry have close kinship. They both have to do with the production, harvesting and marketing of crops grown from the soil. They differ

chiefly in the time required for the crop to mature. Why should we not have state, county and town institutes that impart public instruction in forestry as well as in agriculture? Why should we not have instruction in forestry in certain high schools and other institutions as we now have in agriculture? Why should we not have field demonstrations for the public in forestry as well as in agriculture? Not only have we, in our heroic efforts to erect many professional forest schools, been *negligent in supplying the educational machinery for educating the public in the scientific treatment of woodlands, but we have been equally negligent in supplying the machinery for vocational training.* Although more than fifty institutions in the United States have within the past fifteen years developed more or less work in forestry education below the grade of full professional training, it has largely been without definite aim and has been poorly suited to the real needs of the country. Very little of it even approaches the requirements of the ideal vocational school. As reported by the committee on forestry education at the Fifth National Conservation Congress:

> The vocational forest school should bear the same relation to professional training that the woodshop bears to research in technology or the business school to university instruction in economics and commerce. It is analogous to the trade schools or a system of apprentice training whereby men are equipped for the skilled trades. The vocational school must, therefore, aim to teach the art or trade of forest practise, not the science of forestry.

In order best to serve the purposes of forestry education in the United States at least two thirds of the money now expended on professional training could be better spent in the instruction of the public through the organization of institutes, field demonstrations and similar methods that have been found so effective in agriculture, and in the organization of vocational schools for the training of young men in the art of forestry practise.

What does the experience of the United States in forest conservation and in the development of forestry education teach that can be useful to her sister republics? The writer believes that it teaches the following fundamental truths:

1. *The possibility of forest conservation in any republic which has for its foundation the orderly development of forest property and a sustained yield rests squarely upon organized propaganda which has for its purpose the creation of public opinion favorable to forestry*—a public opinion that is willing to make present expenditures for future welfare.

2. *The keystone in organized propaganda must be centralized in public ownership, i. e.,* absolute forest lands must, so far as present economic conditions permit, be owned by the public and managed by and for the public.

3. *Organized propaganda must continue as an indispensable part of forestry education,* even after the beginning of forest conservation has been effected through public ownership. A strong public sentiment favorable to forest conservation is the only effective weapon for keeping public forests from exploitation by those who consider public property their just prey and await every opportunity to pounce upon it.

4. *Forestry education beyond that attainable by organized propaganda for the purpose of molding public opinion should result in putting the actual practise of forestry into operation upon both public and private forests to the fullest degree consistent with economic conditions.* It can attain this end only by welding together and giving emphasis to each of the following: (*a*) Forestry education when the training is secondary to other work. (*b*)

Vocational training in forestry. (c) Professional training in forestry.

The overstimulation of professional training whereby a much larger number of men of high educational attainments and thorough technical preparation are trained than are able to find professional employment is a waste and detrimental to forest conservation. On the other hand, secondary and vocational training can scarcely be overstimulated. It is the writer's opinion that the progress made in the actual conduct of forestry operations in the woods must center in a vast army with some training rather than full professional training, whose knowledge of forestry is chiefly confined to the art of forestry so far as it concerns their own locality and who do not look for, and should not expect, a wage beyond that which the operations justify.

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ON CERTAIN RELATIONS OF THE LOWER ANIMALS TO HUMAN DISEASE[1]

ONE of the striking tendencies in modern medicine has been an increasing apprecia-

[1] Read at the Quarter-Centennial of the University of Chicago, Departmental Conference in Pathology, June 6, 1916.

tion of the importance of the lower animals in relation to human disease. The subject is a vast one and may be discussed from many standpoints. Medically, animals may serve humanity or they may be directly responsible for terrible scourges. For experimental and teaching purposes in all departments of medicine they are indispensable and this forms one great field of usefulness for them. A second field is their use in the production of curative substances—serums, vaccines, ductless gland preparations, drugs, etc., a field which marks an epoch in modern medicine.

The relation of the lower animals to the transmission and causation of disease is another phase of this subject, but here the results, unlike those in the two fields above noted, are almost invariably serious for the welfare of man. In this field many great and interesting discoveries in recent years have been made. I shall limit myself to this topic and shall try to point out some of the more noteworthy features in this relationship and their bearing on preventive medicine.

Historically, in the very earliest accounts of primitive people, there are records concerning the relation of animals and animal parasites to the causation of disease. In Hirsch's classical work on geographical pathology we find a discussion of the records of the "fiery serpents" (probably the guinea-worms) that afflicted the Hebrews in their wanderings in the desert; and Plutarch narrates that "the dwellers by the Red Sea suffer from a serious malady due to a small serpent which issues from the skin to gnaw the arms and legs and retires underneath the skin if disturbed, causing the patient intolerable pain." Intestinal worms especially were well known to the ancients and form an important chapter in their medicine. In primitive peoples bites and lacerations by wild animals and snakes with the resulting secondary infections following such wounds gave rise to disease. Rabies was known over 2,000 years ago. It is of such a nature that its relation to dogs and other animals could easily be traced and this connection was well appreciated by the medical authorities in those times. Varro (116–27 B.C.) suggested that malarial fevers were transmitted by insects.

A landmark in the relationship of animal and human disease was the observations of Jenner in 1796 on the relation of smallpox and cowpox. The story is well known and need not be related here. It is a splendid example of careful observation, experiment and practical application even for our own day. Many of our most important modern problems—infection, immunity, prophylaxis, anaphylaxis, vaccination—have their beginnings here.

Coming now to the bacteriological era inaugurated by Pasteur during the latter part of the last century we note that the connection and interdependence between many animal and human diseases, though recognized before, became ever clearer and more definite. The work of Pasteur on animal diseases, especially anthrax and rabies, of Villemin on tuberculosis, of Koch on anthrax and tuberculosis, of Loeffler on glanders, of Bollenger on actinomycosis, may be mentioned in this connection. This was the era of great and numerous discoveries and the principles then established have directed and stimulated bacteriologic work to the present day.

Shortly after the advent of the bacteriological era there was superimposed upon this another era, that of protozoology. This may with propriety date from the discovery by Theobald Smith in 1889 of the causal organism (*Piroplasma bovis*) of Texas fever in cattle. A little later Smith and Kilbourne determined that the mode of transmission in this disease was by the cattle tick. The fact should be noted however that many years before, in 1864, Pas-

teur showed that the famous epidemic of silkworm disease in France was caused by a protozoan (*Glugea bombysis*) and this might be considered the first great discovery in this field. Another early discovery in protozoology was that of the malarial parasite by Laveran in 1880. These years, however, were so thoroughly dominated by bacteriologic conceptions that Laveran, thinking that the parasite belonged to the plant kingdom, gave it the name "oscillaria."

The significance of Smith and Kilbourne's discovery and what really marked a new epoch in the study of disease was the principle involved in the mode of transmission of an organism through infected ticks (and only in this manner) and in the fact that a definite series of changes necessary for the propagation of the disease went on in the body of the tick by the infecting agent. Here was an observation that opened a new field in the relation of animals to human disease and upon this basis the great discoveries in connection with the transmission of malaria, yellow fever and many other diseases, especially tropical, were later made. The mode of transmission in such diseases having thus become known their control in many instances has become a relatively simple matter.

To convey an impression of the importance and of the large number of diseases of man carried by the lower animals and as an introduction to a discussion of the varied relations of animals to human disease I will present the following résumé:

HUMAN DISEASES CARRIED

1. By the dog:
   - Rabies.
   - Foot and mouth disease.
   - Helminthiasis.
     - Flukes.
     - Tapeworms (especially *Tænia echinococcus*).
   - Infantile splenomegaly (from dogs through fleas).
   - Trypanosomiasis (*T. gambiense*).
   - Mange.
   - Fleas and ticks.
   - Ringworm.
   - Favus.
2. By the cow:
   - Tuberculosis.
   - Actinomycosis.
   - Anthrax.
   - Cowpox.
   - Tetanus (through vaccine).
   - Foot and mouth disease.
   - Septic sore throat.
   - Rabies.
   - Pus infections.
   - Tenia saginata.
   - Milk sickness.
   - Paratyphoid fever.
3. By the horse:
   - Glanders.
   - Rabies.
   - Tetanus.
   - Sporotrichosis.
   - Anaphylaxis.
     - Serum disease.
     - Odor of horses.
4. By swine:
   - Trichiniasis.
   - Tuberculosis.
   - Anthrax.
   - Cestodes (especially *T. solium*).
   - Trematodes.
5. By sheep:
   - Anthrax.
   - Tuberculosis.
6. By goats:
   - Malta fever.
   - Tuberculosis.
7. By the antelope:
   - Sleeping sickness.
8. By the cat:
   - Rabies.
   - Cestodes.
   - Trematodes.
   - Favus.
   - Ringworm.
9. By rats:
   - Rat bite fever.
   - Bubonic plague (through fleas).
   - Trichiniasis (through hog to man).
10. By ground squirrels:
    - Bubonic plague.
11. By birds:
    - Psittacosis (from parrot).
12. By fish:
    - Tape worms.
13. By arthropods, chiefly insects:
    - Mosquitoes:
      - Yellow fever.
      - Malaria fever.
      - Dengue fever.
      - Filariasis.
    - Fleas:
      - Bubonic plague.
      - Infantile splenomegaly.
    - Ticks and mites:
      - Rocky Mountain fever.
      - Relapsing fever (African).
      - Tick fever of Miana.
      - Japanese flood fever.
    - Lice:
      - Typhus fever.

Relapsing fever (*Spirochæta obermeieri*).
Bed bugs:
Kala azar.
Flies:
Sandfly fever.
Sleeping sickness (tse-tse fly).
Typhoid fever and other infections carried mechanically.
Crustaceans (water flea):
Guinea worm infection (dracunculosis).
Oysters, clams, etc.:
Typhoid fever.
Snails:
Trematode infections (especially bilharziosis).

In this outline I have included the most important human diseases that in one way or another are wholly or to some extent dependent on lower animals for their existence and transmission. As given the list is not entirely complete, and if it were complete to-day it might not be complete to-morrow, so rapidly are discoveries especially in tropical diseases being made. The rôle that lower animals play in the transmission of intestinal parasites, for example, is exceedingly varied and though a prodigious number of these parasites have been described and their hosts and intermediate hosts determined there are still very many about which little or nothing is known. In the outline as given I have mentioned only some of the more important examples in this great group.

I wish now to briefly analyze some of the relations of the lower animals to human disease transmission. We find these relations in certain instances to be very simple, in other instances extremely varied and complex. The direct portals of entry into man are usually through the skin, the respiratory and the gastro-intestinal tracts. In some diseases transmission can occur in only one way. In others the transmission may take place in a great variety of ways. I will first group and summarize the modes of transmission as follows:

I. Infection in man may occur through simple contact with diseased animals. Excretions from lesions of skin, nose, lungs and intestines are the usual vehicles. As examples we may cite glanders, anthrax and cowpox. Previous wounds of the body surface may or in some cases may not be necessary for the transmission. The virus also may enter the body through the respiratory or gastro-intestinal tracts. While often this method of transmission is simple and direct, at times the virus may be carried long distances in very indirect and circuitous routes from the animal to man. This is particularly true of the spore-bearing organisms. Recently an outbreak of several cases of anthrax occurred in England which after considerable difficulty was traced to the use of infected shaving brushes. The anthrax bacilli were recovered from the used brushes as well as from new brushes from the same stock obtained in a store. They were made with hair from a diseased animal.

II. The infectious agent may be carried mechanically from person to person or from animal to person through food or otherwise by a second animal; as in the transmission of typhoid, dysentery, cholera, etc., by flies. Foot and mouth disease is said to be carried over long distances by dogs. Oysters thus transmit typhoid.

III. The animal may through a bite produce a lesion into which the infectious agent is transferred, as in rabies and especially in the blood-sucking insect diseases. Rat-bite fever, which according to the recent work of Hektoen and Tunnicliffe may be caused by the streptothrix of rat pneumonia entering the wound caused by the bite of the infected rat, would be here included.

IV. The parasite may be transmitted to man through the meat of lower animals used as food. It is possible though rare for certain bacterial diseases like tuberculosis and perhaps paratyphoid fever to be

transferred to man from the cow in this way. Tapeworm infections of various kinds are thus transmitted from a number of lower animals.

V. The infectious agent may be transmitted to man through the secretions of the lower animals. Here are included some of the most important and serious of human diseases. Malta fever is transmitted largely in this way through the milk and urine of goats infected with *Micrococcus melitensis*. The malarial parasite is transmitted to man by the anopheles mosquito through its salivary gland. Tuberculosis especially in children is often transmitted from the infected cow through the milk. In this connection the epidemics of streptococcus sore throat are interesting. Over thirty milk-borne epidemics of this infection have been reported and from the recent work of several investigators it would seem that in some instances virulent streptococci of the human type may find their way into the udder of the cow through the contaminated hands of the milker and there multiply and return subsequently in large numbers in the milk and infect the consumer. Some of these epidemics and perhaps many of them have originated thus. Capps and the writer several years ago and more recently Mathers have shown experimentally that virulent human streptococci when placed on the abraded teat of a cow will ascend the canal and infect the udder; or when injected directly into the udder will continue to multiply there, causing a mild or even a severe mastitis lasting for several weeks or for months. The streptococci in large numbers will pass out in the milk during this period and will retain their initial virulence for animals. Other kinds of infections may be transmitted in this way though perhaps rarely. True diphtheria bacilli, for example, have been isolated by Dean and Todd from the ulcerated teats and from the udder of a cow supplying families in which a diphtheria outbreak occurred.

Milk is such an universal food for both men and bacteria that it has been the vehicle for the transmission of many of the infectious diseases. In the outline given I have not mentioned the diseases which may be transmitted through milk, the virus having entered the milk after leaving the cow. In such infections the animal is not concerned directly in the transmission but only indirectly through its product.

VI. The infectious agent may enter one of the lower animals in which it passes through a regular phase or completes a cycle and then, usually through a bite of the animal, is transmitted to man. This mode of transmission concerns many of the protozoan diseases. We may group such infections under two heads: (*a*) those transmitted from man to man by a lower form, examples of which are the malarial parasite in the anopheles mosquito and the yellow fever virus in the stegomyia mosquito; and (*b*) those transmitted from an animal to man by one or more of the lower forms, illustrated by the transmission of *Trypanosoma gambiense* from the antelope or from the dog or the monkey to man through the tse-tse fly. In this case one or more of the lower animals are concerned in the transmission of a second animal, the parasite, to a third animal, man. Both (*a*) and (*b*) may occur in the same disease. The principle of host and intermediate host here involved is a very important one and numerous examples might be given. Many of the intestinal parasites, the entozoa, pass a part of their cycle of development in a lower animal. Most interesting relationships exist in this connection between some of the nematoda and the trematoda or fluke infections in man and certain small water animals, including crabs, snails and other arthropods. For example the guinea-worm,

a filarial parasite in man, lives in the tissues and at times the female bores outward through the epidermis, discharging the embryos which, if they find water, swim about and enter a small crustacean, the waterflea or cyclops, in which they remain for several weeks undergoing certain transformations. Finally they may enter the stomach of man through drinking water and then bore through the stomach wall into the tissues again. The liver fluke, common in sheep causing the disease "sheep rot" and occasionally found in man, uses several varieties of snails as hosts passing through certain rather complex changes and later leaving the snail to become encysted on grass or weeds which are eaten by sheep.

Through the recent work in Egypt of Colonel Leiper and his associates in the Royal Army Medical Corps it seems now to be firmly established, contrary to the views of Looss, that the fluke, *Schistosoma hæmatobium,* the cause of bilharziosis, after leaving the body in the urine uses the snail as an intermediate host in which it undergoes a metamorphosis before it is capable of infecting another person. Infection with the fluke actually takes place both by mouth and through the skin of the individual. It has been shown that eradication of this very prevalent and serious disease in the Orient will depend upon the destruction of snails, the cooperation of the infected individual not being necessary.

This résumé in a general way I think includes the modes of transmission of at least most of the human-animal diseases as we at present know them.

I wish now to call attention to a number of points which are frequently of great importance in the control of many of these diseases. For convenience of presentation I will mention them under four heads:

1. A lower animal may be the only agency in the spread of a disease. In malaria the available evidence indicates that the disease is spread only by the anopheles mosquito, although several varieties of this species harbor the parasite. So also yellow fever is spread, so far as we now know, only by the stegomyia mosquito.

2. Several different species of lower animals may be concerned in the transmission of the disease. As examples we may cite rabies which is transmitted by dogs, cats, wolves, horses and other animals; anthrax by sheep, cows, etc.; bubonic plague by rats and ground squirrels. The question as to whether a given disease is transmitted by one animal only or by several is so important so far as control measures are concerned that I need only pause to mention it.

3. The lower animal may be a "healthy" carrier. That is, the infectious agent though perhaps highly virulent to man may not cause the animal to become sick. A striking example of this condition is the Malta fever infection (*M. melitensis*) in goats. Malta fever, a human disease very common in Mediterranean countries and now prevalent in our southwest, is spread through the milk of goats. In most of these animals there are no symptoms whatever, the micrococcus being found in the milk or urine or blood of animals perfectly healthy and which remain so. Typhoid bacilli may live in the intestinal canal of flies. Tetanus bacilli may live for months in large numbers in the intestinal canal of horses, certain of these animals becoming virtually tetanus "carriers."

4. The lower animal may be a diseased "carrier"; that is, the infectious agent may cause the lower animal to become sick. Glanders in horses, rabies in dogs, anthrax in sheep are examples. This matter of degree of reaction or the severity of the disease in the animal is of very great importance in the control of the disease. From the standpoint of man's welfare it is often highly advantageous that the infection in

the animal should not only show symptoms but should be rapidly fatal so as to remove the source of danger as soon as possible. Malta fever is a very different disease to control because the goats so often show no clinical symptoms. Also a chronic disease in animals is a source of danger for a long period of time whereas the acutely fatal diseases terminate the danger quickly. Chronic glanders in the horse as compared with acute glanders illustrates well this point. Furthermore by the death of the animal in the rapidly fatal diseases usually the more highly virulent and hence the more dangerous strains of microbes are destroyed at the same time.

Usually the natural animal diseases transmissible to man are deleterious to him. Occasionally a natural animal disease has been made to serve a good purpose by furnishing a means for protective inoculation in man. Cowpox is an example, the natural virus being continued in the cow and then transferred artificially to man for protective purposes against smallpox. The Pasteur treatment in hydrophobia depends on much the same principle, the virus being propagated however in another animal, the rabbit, the spinal cord of which is then artificially inoculated into man for preventive purposes.

As a result of the use of animal products for protective and curative purposes in medicine, there is produced at times the condition of anaphylaxis known as "serum disease." This reaction is so serious that it may actually interfere with the use of serums over long periods of time in the treatment of chronic disease. The success of serum therapy has so far been confined largely to acute diseases which ordinarily do not require long treatment, so that the danger of anaphylactic shock has not in this respect seriously restricted the use of serums. In this connection might be mentioned the state of certain individuals who are hypersensitive perhaps naturally to the odor of horses and when near the animal manifest definite symptoms of an anaphylactic character.

Certain diseases common in animals and man exist in which there is little or no evidence that man is infected directly from the animal. Actinomycosis is such a disease. It is doubtful if there is a case on record in which man became directly infected with the actinomyces through contact with a diseased animal. Sporotrichosis likewise is common in horses and in man, but there is but one or two cases where direct infection occurred and this was through the bite of a horse. In such diseases the animals are dangerous not so much through direct contact as through the general dissemination of the microbes upon soil, grass, fodder and various objects, thereby greatly increasing the opportunity for human infection in a variety of indirect ways.

While man receives a large number of diseases from or through the lower animals, if we inquire into the reverse proposition, we find that any one of the lower animals though suffering on the whole from many diseases, acquire relatively few from other animals including man. The horse, for example, receives rabies from dogs, and occasionally anthrax from sheep and cows. Tuberculosis hardly exists in this animal. In the tropics it has its diseases carried by flies and ticks though they apparently are not as numerous as the human diseases so transmitted. The cow appears to be somewhat more susceptible to diseases from other species than is the horse but apparently not as susceptible as man to such. The dog and the other animals enumerated, all have a host of their own diseases, relatively few of which seem to depend on some other animal for their transmission. Exception might be taken to this statement concerning the lower animals. It may be that it

only appears to be true because we know more about the diseases of man than those of the lower animals.

Certain reasons may be here enumerated why man is subject to at least many of the animal diseases. Man is commonly concerned in caring for sick animals and some diseases, like glanders, are commonly transmitted in this way to veterinarians, hostlers and teamsters. The demand of the human for animal pets and the social demands of certain types of humanity for dogs, cats and other animals living in intimate association with them explains the origin of certain diseases, especially those parasitic in character. Man lives largely on meat and other animal products, many of which are uncooked or improperly cooked. Man uses animals in a variety of ways in the industries, the relations being often such as to necessitate intimate contact. Again, wild animals are free from many diseases but domestication or confinement by man may make them highly susceptible. Such animals then may become a source of danger to man and thus a vicious circle is established.

The transfer of certain diseases from animals to man is, under existing conditions, not a reversible process. Rabies is commonly transmitted from dog to man but practically never, so far as we know, in the reverse direction. This is true of many diseases and depends upon such factors as the superior care given to the human sick and the methods of isolation.

It would seem then that man's relations and points of contact with a large variety of the lower animals are more intimate and complex than those of any of the other animals to other species and as a result of such relations, on the whole, the disease transmission from animals to the human is naturally increased in number and variety. This is one of the penalties that man pays for being nurse, doctor and master of the brute creation.

While animals play such a very important rôle in the transmission of disease to man it is interesting to note that plants play practically no rôle whatsoever in this regard. Though plants are afflicted with microbic and fungous diseases to an extent probably even greater than are animals, only one organism is known which is apparently pathogenic for both plants and man. According to the work of Johnston,[2] cocoanut budrot, a disease of the cocoanut common in Cuba, is caused by an organism practically identical with *Bacillus coli* (Escherich) Migula. Inoculations into cocoanut seedlings with *B. coli* of animal origin give infections similar to inoculations with the cocoanut organism. It may be stated, however, that this plant disease is of no significance, so far as we know, in the transmission or the causation of human disease, since *B. coli* ordinarily does no harm when taken into the alimentary canal. It is true, of course, that many plants carry disease germs such as typhoid and dysentery bacilli mechanically upon their surface where they may remain alive for some time and in this respect play a rôle comparable to that of flies in the transmission of typhoid fever.

The higher plants being so remote biologically from the higher animals it is improbable that specific disease germs pathogenic to these two types of organisms will be found. However it is possible that plants may be found which serve as intermediate hosts for organisms not pathogenic for them but pathogenic for certain animals. Many of the viruses and parasites which cause disease in man use some lower form of animal biologically far removed from man for a certain period of their de-

[2] "The History and Cause of the Cocoanut Budrot," Bull. No. 228, Bureau of Plant Industry, 1912.

velopment, but do not cause symptoms in this animal. The malarial parasite and the yellow fever virus do not seem to injure the mosquito. Nor does the virus of Rocky Mountain fever injure the tick or that of typhus fever the louse. There is, as we know, some degree of parallelism between biological relationship and susceptibility to a given virus. But this susceptibility has nothing to do necessarily with the ability of an animal to serve as an intermediate host or to harbor a parasite.

The question of adaptation in this connection should be mentioned. It is a problem which for a long time has interested the bacteriologist, but by none has its importance been more clearly grasped than by Pasteur who was influenced so decidedly in his experimental work on animals by this principle. In the relation of disease to animals most of the important points center around this fundamental idea in one form or another. It goes hand in hand with the principle of specificity. A given organism supposedly specific for a given animal may acquire the property by adaptation of growing in the body of another animal. It has widened its sphere of activity in certain respects but in other respects it is as specific as ever. Specificity like immunity is a phase of the principle of adaptation. In the study of human-animal disease we note that some organisms naturally are adapted to grow in a variety of animals, others limited very decidedly to a particular animal and even to a particular race of a given species. By experiment these latter may be made to widen their sphere of activity very appreciably. As specific illustrations I may cite the early contributions of Welch and the recent work of Gay and Claypole in causing the typhoid carrier state in rabbits; also the work of Culver in increasing by repeated transfers the resistance of the gonococcus to rabbit serum and the infection of rabbits with such a strain. Some strains of bacteria identical when tested by our most refined laboratory methods may be highly pathogenic for a given animal but non-pathogenic for even a closely related species.

As to the importance of such processes of adaptation in nature for the dissemination of disease from one variety to another or from animal to man, it is very difficult to obtain, experimentally or otherwise, definite data extending over a sufficiently long period of time to be of value. We can at present perhaps conceive of no better hypothesis for the origin of infections and their continuance. Bacteria are very old, there being definite evidence, as shown by B. Regnault and by Moodie of the existence of bacilli and cocci in the intestinal canal of animals (coprolytes), in decomposing plant and animal remains and probably also as disease producers in the Mesozoic and Pleistocene era ten to twelve millions of years ago. Far less change were necessary in the bacteria to develop into the types of to-day than have occurred in animals since that time.

There are many infectious diseases whose modes of transmission are at present obscure which no doubt will be found to be carried by some lower animal form. As an example of such may be mentioned Rocky Mountain tick fever, in which suggestive evidence exists of a relation to some wild animal, possibly the gopher (spermophilis), as a tick-carrier. The work of Strong and his associates on the two South American diseases, verruga peruviana and oroya, would indicate that they are transmitted by some arthropod. This has not yet been demonstrated. The modes of transmission of many trematode and nematode infections have not yet been discovered, but from what is known of such diseases there can be little or no doubt that many are transmitted through another animal. Infantile paralysis has been transmitted ex-

perimentally from animal to animal by flies but it has not yet been shown that flies play a significant rôle in human transmission. As to the fly it is difficult to determine how important it is in the transmission of a number of infections.

While much suggestive evidence exists concerning the rôle of animals in carrying certain diseases whose origin is still obscure, on the other hand, there is in the literature much loose speculation as to the rôle animals play in many such diseases. Superstition and tradition enter at times to aid this speculation. The older literature contains many articles on the rôle of dogs, cats, and other domestic animals in the transmission of the various contagious diseases, especially diseases of children. Syphilis, measles, scarlet fever, smallpox, etc., have been thought to be transmitted by lice, bed bugs, flies and other blood-sucking insects. Occasional instances of such modes of transmission have perhaps occurred or are possibilities, but there have been much worthless discussion and speculation on these subjects.

In the solution of the various problems that arise in connection with prevention of human-animal diseases no one rule can be established for their control. In the first place each disease must be studied by itself and its natural history in detail should be known in order to intelligently cope with it. Upon personal hygiene and care in all matters concerning diet, clothes, housing conditions and our relations to animal life as well as upon close observance of sanitary rules will largely depend the solution of these problems.

As already stated nearly all of these diseases are easily preventable once the true natural history of the disease is known. The serious problem then is usually the education of the public. To illustrate, in hydrophobia prevention centers around the problem of the muzzling of dogs. This has been known for decades, yet the American people prefer to have 5,000 persons, mostly children, bitten each year and a hundred or more deaths, than to subject their dogs to the discomfort of a muzzle and to destroy the stray and worthless curs of the street. It should be said that this has been true in the past. Now the problem has become far more serious. In our western states rabies has spread during the past year to the coyotes, wolves and other wild animals which wander about biting domestic animals, especially stock, and even attacking persons, particularly school children. Our government has now spent large sums in an attempt to control the disease, but, once in wild animals, it is known to be very difficult to eradicate. Thus the matters stand at present with this human-animal disease. Such an experience should serve as an example, and many others might be given, in this matter of the importance of animals to human diseases and their control.

The study of comparative pathology, it would seem, should occupy a more prominent place in the curricula of our universities and medical schools than it has in the past. When we consider the fundamental character of the studies in this field of pathology—the work of Jenner, of Pasteur, of Koch, of Theobald Smith and especially of a great group of investigators in recent years on cancer and on tropical diseases in man and animals—the truth seems evident that in the study of disease and in its presentation to students such an important field should not be slighted. Our study of disease in medical and veterinary institutions should be at least as broad and as comparative as is the study of zoology or botany. In order to understand the natural history of many diseases comparative studies are absolutely necessary. It would undoubtedly be advantageous both from a humane as well as from a scientific

standpoint if our medical schools and hospitals, our veterinary hospitals and even our cat and dog hospitals and other places for the care of sick animals could all be concentrated in one institution for the broad study of disease. This indeed is now being attempted in certain institutions and no doubt will result in a broader conception of pathology.

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INVESTIGATIONS AT THE WOODS HOLE BIOLOGICAL STATION OF THE UNITED STATES BUREAU OF FISHERIES

THE laboratory of the Woods Hole Biological Station of the United States Bureau of Fisheries opened for the season's operations on June 19, under the directorship of Dr. P. H. Mitchell of Brown University. The various investigators are: Dr. W. W. Browne, of the College of the City of New York, who is studying various phases of bacteriology of fishes including bacterial changes during cold storage and the occurrence of pollution bacteria in food fishes; Dr. I. A. Field, of Clark University, who is completing a comprehensive report on the biology and economic value of the sea mussel and is conducting investigations on its embryology; Dr. C. W. Hahn, of the New York City High School of Commerce, who is studying sporozoan parasites of fishes with especial reference to modes of infection; Dr. Edwin Linton, of Washington and Jefferson College, who is studying fish parasites and the food of certain fishes; Dr. Sergius Morgulis, formerly of the College of Physicians and Surgeons, who is continuing researches on the metabolism of fishes; and Dr. G. G. Scott, of the College of the City of New York, who is studying the oxygen requirements of various marine forms and the oxygen consumption of developing fish embryos. The scientific assistants are: Mr. A. E. Barnard, of Brown University, who is working with the director on the nutrition of oysters; Mr. R. L. Barney, of Brown University, who is aiding the director in the study of diatoms of green gill oysters and the life history of sporozoan parasites; Mr. F. R. Dieuaide, of the College of the City of New York, who is assisting Dr. Scott and is making a collection of Woods Hole marine flora; Mr. E. W. Fuller, of Amherst College, who is assisting Dr. Morgulis; and Mr. K. S. Rice, of Brown University, who is assisting the director in the study of the food supply of oysters.

The facilities of the laboratory have also been extended to the following table applicants: Dr. N. A. Cobb, of the Department of Agriculture, and the Misses Cobb and Mr. Alfred Steinberg, who are assisting Dr. Cobb in the study of the physiology of nematodes; Dr. S. A. MacCallum, of New York City, who is investigating fish parasites, especially the helminthes; Dr. Albert Mann, of the Department of Agriculture, who is studying the diatom flora of the Woods Hole region; Dr. A. M. Reese, of West Virginia University, who is investigating light reactions of *Diemyctylus;* Mr. A. C. Redfield, of Harvard University, who is studying the melanophores of lower vertebrates especially in relation to adrenal glands of fishes; Mrs. A. C. Redfield, who is studying respiration in lamellibranchs; Dr. F. P. Reagan, of Princeton University, who is studying the development of *Fundulus heteroclitus;* and Mr. C. C. Speidel, of Princeton University, who is sharing a table with Dr. Reagan, and is investigating the function of certain peculiar cells of the spinal cord of the skate. The facilities of the laboratory will also be granted, during September, to Dr. F. C. Weber and assistants, from the Bureau of Chemistry, for investigations concerning copepods as food for sardines. The laboratory closes on September 15.

P. H. MITCHELL
WOODS HOLE, MASS.,
August 29, 1916

SCIENTIFIC NOTES AND NEWS

THE American Astronomical Society met in the Sproul Observatory, Swarthmore College,

from August 30 to September 2, with Dr. E. C. Pickering in the chair.

Dr. Thomas H. Macbride has been elected president emeritus of the State University of Iowa, on his retirement from the presidency which he accepted two and a half years ago. Dr. Macbride had been assistant professor and professor of botany in the university since 1878.

Dr. L. H. Baekeland has been appointed to represent the American Chemical Society on the Natural Research Council being organized by a committee of the National Academy of Sciences.

The Alvarenga prize this year in Brazil was awarded to G. Riedel, chief of the biologic chemistry service at the Hospicio Nacional and instructor at the university. His work described researches on the protective ferments, and a process for determining the specific ferments by superficial tension.

Professor Charles Richet, of the University of Paris, has been awarded the state prize for poetry. The subject was "The Glory of Pasteur."

We learn from *Nature* that Dr. A. Lauder, of the Edinburgh and East of Scotland College of Agriculture, has been elected honorary secretary of the Edinburgh and East of Scotland section of the Society of Chemical Industry, in succession to Dr. J. P. Longstaff, now general secretary of the society in London.

Dr. Herbert R. Brown has resigned from the position of assistant director of the Massachusetts State Department of Health to accept an appointment as pathologist at the Rochester Homeopathic Hospital at Rochester, N. Y.

The position of assistant botanist to the Missouri Botanical Garden has been filled by the appointment of Mr. J. C. Th. Uphof, for the past three years assistant professor of botany at the University of Arizona.

On the initiative of the Royal Society a Board of Scientific Societies has been established in Great Britain to promote the cooperation of those interested in pure or applied science; to supply a means by which the scientific opinion of the country may, on matters relating to science, industry and education find effective expression; to take such action as may be necessary to promote the application of science to industries and to the service of the nation; and to discuss scientific questions in which international cooperation seems advisable. The board at present consists of representatives of twenty-seven scientific and technical societies. An executive committee has been appointed, consisting of Sir Joseph Thomson, O.M., president of the Royal Society, chairman; Dr. Dugald Clerk, F.R.S., Sir Robert Hadfield, F.R.S., Mr. A. D. Hall, F.R.S., Professor Herbert Jackson, honorary secretary, Sir Alfred Keogh, K.C.B., Sir Ray Lankester, K.C.B., F.R.S., Professor A. Schuster, secretary of the Royal Society, Sir John Snell, Professor E. H. Starling, F.R.S., Lord Sydenham, F.R.S. and Mr. R. Threlfall, F.R.S. The first meeting of the board was held on July 20, when questions relating to scientific, educational and industrial matters were under consideration.

The American Association for Clinical Research will hold its eighth annual meeting in New York, September 28, 29 and 30, with headquarters at the Hotel Majestic. There will be three sessions each day, morning, afternoon and evening. Clinics will be held at the Flower, Metropolitan and other hospitals. Dr. Daniel E. S. Coleman, of New York, is president of the society, and Dr. James Krauss, 419 Boylston Street, Boston, is permanent secretary.

Donald B. MacMillan, who went in 1913 in search of "Crocker Land," will arrive home within a month, according to a message received by the officers of the American Museum of Natural History. His party will be with him, including Dr. E. O. Hovey, who had charge of the relief expedition sent to MacMillan in 1915 on the schooner *George B. Cluett*. The party is expected to reach St. Johns, N. F., between September 20 and October 1. The explorers are returning on the Danish steamer *Danmark*, chartered by the museum from the Greenland Mining Company. They will stop on the way at Thule to pick up

Dr. Hovey and his party, and it was expected that Knud Rasmussen, who has been in Greenland for two years, will join them.

ACCORDING to a press dispatch from Punta Arenas, Chile, Lieutenant Sir Ernest H. Shackleton has rescued the members of his Antarctic expedition who were marooned on Elephant Island. Lieutenant Shackleton returned to Punta Arena on September 3 with his men safe and well on board the rescue ship *Yelcho*. This was the fourth attempt made by Sir Ernest Shackleton to rescue the twenty-two men who had been marooned on Elephant Island since April 24. The other attempts, made during June and July, failed on account of unfavorable ice conditions.

DR. W. G. MACCALLUM, professor of pathology in Columbia University, expects to return to New York this month from a trip to Honolulu, Fiji, New Zealand, Australia, Java, Borneo, Celebes and Sumatra. During this trip, which has lasted since February, he has given some attention to prevailing diseases in these islands.

DR. GEORGE T. MOORE, director of the Missouri Botanical Garden, has returned from a trip, which has lasted since February, he has spent a few days at the biological station of the University of North Dakota, collecting and studying the algæ of that region.

DR. GEORGE W. CRILE, professor of surgery in Western Reserve University, on August 25, gave an illustrated lecture before the graduate school in medical sciences of the University of Illinois, Chicago, on "Exhaustion and Restoration." On August 31, Professor C. R. Bardeen, dean of the medical school of the University of Wisconsin gave a lecture before the school, his subject being "Study of the Anatomy of the Heart in the Living by Use of the X-ray."

PROFESSOR BURTON D. MEYERS, of the University of Indiana, recently gave an illustrated lecture on "The Normal Position of the Human Stomach" to the faculty and students of the Graduate School in Medical Sciences of the University of Illinois.

THE Archangel Society is collecting the sum of $12,500 to obtain information of two Russian expeditions which sailed in 1912 under Lieut. Brusiloff and M. Rousanoff.

PRESIDENT WILSON has signed the bill recently passed by Congress appropriating $35,000 for the erection at Washington of a memorial to John Ericsson, inventor of the Monitor and distinguished as an engineer.

PROFESSOR THOMAS GREGOR BRODIE, associated with Professor A. B. Macallum, in the department of physiology of the University of Toronto since 1908, died on August 20, at the age of fifty years. Professor Brodie was in London, where he was serving as a captain in the Canadian Army Medical Corps.

MR. CHARLES DAWSON, who died on August 10 at the age of fifty-two years, was a solicitor, who devoted attention to the fossil remains of reptiles found in the Wealden formations quarried round Hastings, and made a large collection, which he placed in the British Museum. In 1912 he discovered the now famous skull and mandible of *Eoanthropus dawsoni* in a very old gravel at Piltdown.

AT the beginning of July, as we learn from *Nature*, a party of thirty men, led by Mr. Birger Johnsson, left Sweden for Spitsbergen in order to work the coal deposits at the head of Bell Sound (Braganza Creek) and Isfjord. At Braganza Creek the coal, though of Tertiary age, is said to be of good burning quality, and there is an average thickness of 2.15 meters over an area of about 100 kilometers. At the Pyramid Hill and in Bünsow's Land, at the head of Isfjord, on the other hand, the coal is culm of Carboniferous age, and is not so good as at Braganza. None the less, these two areas are calculated to yield about 3,000 million tons of good coal. Other members of the expedition are Mr. S. Öhman, who will be responsible for the mapping; Mr. H. Odelberg, agronomist, who will see to the provisioning; Mr. E. Lundström, who will serve as botanist and make a map according to Professor De Geer's photographic method; and a paleontologist, Mr. Erik Andersson, of Upsala, who was recently studying the fossil fishes of Spits-

bergen in the British Museum. Mr. Lundström is taking some plants to see if they will grow there.

UNIVERSITY AND EDUCATIONAL NEWS

Recommendations that a fund of more than $3,000,000 for the treatment of cancerous, nervous and disabling ailments be given to the University of Pennsylvania Hospital has been made by Dr. Winford H. Smith, superintendent of the Johns Hopkins Hospital, Baltimore, who was selected by the trustees of the fund, jointly the incorporated trustees of the Philadelphia Yearly Meeting of Friends and a body organized as the board of managers of the Jeanes Hospital, to come to Philadelphia and make a survey of its hospitals and medical work and give them his opinion as to where the fortune would work the greatest benefit. The fund is the estate and its increment willed for the purpose by Anna J. Jeanes, a noted Friend philanthropist, who died in 1908.

Mr. Blanchard Randall and Dr. Howard Kelly have presented to the Johns Hopkins Hospital a collection of portraits of medical men said to be of great value. The collection given by Mr. Randall, who is one of the trustees of the institution, consists of forty-eight portraits. Dr. Kelly, who is one of the consulting physicians, added eleven portraits.

Miss S. E. S. Mair and Mrs. A. M. Chalmers Watson, on behalf of women medical graduates, students and their friends, have offered to pay to the Edinburgh University $20,000 for the medical education of women.

The report of President R. S. Hyer to the board of trustees shows that the enrollment of the initial year of the Southern Methodist University reached 706 students, 453 of whom were in the academic department. Over 300 students in the academic department carried science courses during the year. In the choice of a science, chemistry, physics, biology and geology registered practically the same number. The total enrollment is said to establish a new record for the initial year in American universities. The University of Chicago registered 698 in its first year.

Dr. W. W. Cort, Ph.D. (Illinois, '14), professor of biology at Macalester College, St. Paul, Minn., has accepted a position as assistant professor of zoology at the University of California. Dr. H. D. Gould, Ph.D. (Princeton, '16) has been appointed instructor in zoology in place of Assistant Professor J. A. Long on Sabbatical leave.

Appointments at the Massachusetts Institute of Technology have been made as follows: Dr. Frederick G. Keyes, associate professor of physico-chemical research; Eugene Olaf Christiansen, instructor in business management; Clarence K. Reiman, instructor in inorganic chemistry; Ernest W. Wescott, research associate in applied chemistry; Robert E. Wilson, research associate in applied chemistry; Charles L. Burdick, research associate in physical chemistry; John G. Barry, instructor in geology and mineralogy, and Alexander Klemin, instructor in aeronautical engineering.

DISCUSSION AND CORRESPONDENCE

THE FUNDAMENTAL EQUATION OF MECHANICS (IV)

In his paper on "The Accepted Facts of Dynamics,"[1] Professor Hoskins proposes as a sort of challenge a simple problem which he believes can not be solved by means of my fundamental equation $F/F' = a/a'$ without the aid of a further principle which he calls the *additive property of mass*. This challenge seems to me a fair one, and without reopening the general discussion, I should like to show how easy it is to offer a solution of this problem based entirely on the principles I have set forth as sufficient.[2] The problem is as follows:

> A first body, A', is observed to have an acceleration a' when acted on by a force F; a second body, A'', is observed to have an acceleration a'' when acted on by an equal force F; if the two are combined into a single body, what acceleration will this body have if acted on by a force F?

[1] Science, June 30, 1916.

[2] Science, February 5, 1915; July 30, 1915; and especially March 3, 1916. Further discussion of this topic may be expected to appear in the *American Mathematical Monthly*.

It will be noticed that we are here concerned not with a single particle, but with a collection of two particles, so that we may expect the *principle of action and reaction* to be called into service. (This principle was included in my paper, in a footnote.) The solution I would propose is as follows:

Since the force F applied to the composite body must be applied at some point, let us suppose that it is applied at the A' end of the body; and since the two parts A' and A'' must be connected together by some means, let Q be the force which each part exerts on the other. If now we confine our attention to the first body, A', we see that the net force acting on this body in the forward direction is $F-Q$, while the acceleration produced is the required acceleration of the combined body, say a; hence, by the fundamental proportion as applied to the first body,

$$(F-Q)/F=a/a'.$$

Similarly, if we confine our attention to the second body, A'', we see that the net force acting is Q, while the acceleration produced is the same as before, namely a; hence, by the fundamental proportion as applied to the second body,

$$Q/F=a/a''.$$

Solving these two equations for a, we have at once the required answer:

$$1/a=1/a'+1/a''.$$

It is obvious that the proof just given—involving the elimination of the internal forces Q—is nothing more than a special case of the proof regularly employed for the familiar theorem on the motion of the center of mass of any collection of particles. In fact, as far as I can make out his meaning, *all that Professor Hoskins values so highly in his (rather vague) principle of the additivity of mass is really contained in this well-known theorem on the motion of the center of mass.* If this is true, the chief difference between the methods advocated by Professor Hoskins and myself comes down to this: *he would regard as a fundamental assumption, to be stated as such at the very outset of the course, a rather complicated proposition called the additivity of mass, while I would prefer to treat this proposition as a theorem to be deduced by easy steps from much simpler fundamental assumptions.*

In conclusion, there are two minor points in Professor Hoskins's paper on which I may be permitted to comment.

First, I can not assent to Professor Hoskins's characterization of my method as one that "purports to be independent of mass." It is true that my method purports to require, at the start, only three fundamental concepts, namely: force, length and time; but the concept of mass is no more "ignored" or "evaded" in the development than are the concepts of energy, momentum, etc., all of which take their proper places in the theory as derived concepts. *The kinetic idea of mass or inertia (namely, force over acceleration) is as difficult as it is important, and should be led up to gradually, by easy and very definite steps.*[3]

Secondly, I can not admit that my method requires me to define "the unit force" as "the force which would give the unit mass 32.1740 units of acceleration." On the contrary, my idea of a force is a spring balance, and my idea of a unit force is any spring which may happen to be selected as a standard. It is a matter of entire indifference in my method whether the unit force is a pound or a dyne or a pennyweight.

EDWARD V. HUNTINGTON
HARVARD UNIVERSITY

SIR CLEMENTS MARKHAM

TO THE EDITOR OF SCIENCE: It was a great pleasure to me to read the appreciation of Sir Clements Markham which came out in SCIENCE for April 21. Too often have the admirers of Sir Clements in this country had reason to believe that his anthropological labors are not properly appreciated here. Such a full, generous and complete résumé of his great accomplishment as that given by A. C. B. contributes toward a contrary belief.

Through Sir Clements Markham's extraordinary diligence and scholarship, students of South American anthropology are given ready access to Garcilasso de la Vega's "Royal Com-

[3] Compare the excellent remarks of Professor Willard J. Fisher in SCIENCE for July 7, 1916.

mentaries," to Pedro Sarmiento de Gamboa's diametrically opposed "History of the Incas," to the reliable and unbiased Cieza's writings, and to many other equally valuable works. Nor are Sir Clements's own works to be left unread by any student of the subject. He did more than any other one man for South American anthropology.

Perhaps the most endearing trait of the great scholar's character was his unselfishness. It happened that I ran across a copy of a certain rare book on Peru. Although I did not then know Sir Clements I ventured to write to him and ask him whether it would be worth while to publish an English translation of the work. He replied that it would. Although he himself had already made a translation (still in MS.) he encouraged me to go ahead with mine and he personally made arrangements for its publication in England. Such generosity is of the best sort. It shows that Sir Clements placed the advancement of knowledge above his own advancement, and it shows that he was glad to help even an unknown beginner by a personal sacrifice.

X.

SCIENTIFIC BOOKS

The Horse in Health and Disease. F. B. Hadley. W. B. Saunders and Co., Philadelphia.

This book, designed as an introductory text to the study of veterinary science in agricultural schools and colleges, ought to fulfill its purpose. The author is to be congratulated upon his judgment in selecting the most suitable material. He has succeeded in bringing together in a condensed form a number of branches of veterinary science.

Although couched in scientific terms, most of which are defined with their first appearance, the book ought to be intelligible to a careful reader. The arrangement is complete, leaving little to be desired. The horse is taken as the type. Beginning with the anatomy and physiology, the structure and function of the normal or healthy animal is explained. This knowledge is indispensable to one expecting to recognize abnormal conditions. Then follows a brief description of a great variety of diseases, together with measures of control.

By way of adverse criticism, very little can be said. In discussing the subject of diagnosis of disease, there occurs: "Even an experienced diagnostician fails to make an absolutely accurate diagnosis in more than 50 per cent. of his cases." This must be very discouraging to a novice and the facts of the case do not render the statement justifiable. To be sure, the word *absolutely* makes the statement invulnerable, but the impression created is detrimental and uncomplimentary to the author's profession. Under retention of the urine occurs the following: "The bladder of the stallion or gelding can be emptied only by use of the catheter." Practitioners frequently evacuate the bladder of males by pressure upon the bladder per rectum, even upon recumbent animals.

The illustrations, most of which are photographs, are clear and numerous. The excellent paper and the clearness of the type are characteristic of the publishers.

V. G. Kimball

Philadelphia, Pa.

QUOTATIONS

THE CONTROL OF EPIDEMIC INFANTILE PARALYSIS

The severe epidemic of infantile paralysis—or acute anterior poliomyelitis, to give the disease a more descriptive title—that now prevails in New York has not unnaturally given rise to a certain degree of anxiety in our own country also. During the last two months this epidemic has caused the death of some 1,400 children in New York, the mortality being about 25 per cent.; comparatively few adults have been attacked. Quarantine regulations are now being widely enforced in the neighboring districts, and children under 16 years of age, we read in the *Times*, are forbidden to travel, to the vast inconvenience of holiday-makers. The public health authorities in New York are only too familiar with epidemic infantile paralysis, for the disease is always present and always more or less active in that cosmopolitan town. They are endeavoring to limit the epidemic by the isolation or quaran-

tine of the most susceptible part of the population—that is to say, of the children. No more effectual way of dealing with the situation is known.

The disease is one that has been studied with great success during the last few years in America, more particularly by Flexner and his pupils, to whom we owe many of the recent discoveries made as to its etiology and the way in which it may be communicated from one person to another. The great advances made in this regard during the last five or six years may perhaps be shown by a brief history of the disease. It was first isolated as a distinct entity from the mixed mass of paralyses affecting children by von Heine in 1840, receiving the name "spinal paralysis of children"; naturally there could be no exact knowledge of its pathological anatomy at this early date. Two or three decades later Prévost and Vulpian, Charcot and Joffroy and others described accurately the microscopical lesions that could be found in the spinal cords of patients dying of the disease. In 1890 Medin, taught by the study of a Swedish epidemic of infantile paralysis, extended our knowledge of its various clinical types, particularly in the symptomatology of their initial stages. Further advances were made by Wickman in 1905 and the succeeding years, particularly so far as the epidemiology of the disease is concerned. Many other physicians and pathologists could be mentioned as having cleared up various obscure points in connection with infantile paralysis, or, as it is sometimes termed, Heine-Medin's disease, or the Heine-Medin-Wickman disease; its bacterial cause was looked for with great persistence, and between the years 1898 and 1907 was identified by a number of observers, quite wrongly, with various cocci cultivated from the cerebro-spinal fluid of patients who had or had died of the disease. Fuller experience, however, proved that errors had been made here, and in 1911 Römer summed the matter up correctly when he said that the true bacterial cause of the disease was still unknown. Both cultural experiments and experiments on animals had failed to reveal it. Yet the seasonal and epidemic incidence of infantile paralysis and the inflammatory character of the lesions observed in it *post mortem* made it certain that some living and transmissible virus was the cause of the disease.

So far as its transmissibility was concerned, Landsteiner and Popper have shown that certain apes—hamadryads and macaques—could be infected with a disease indistinguishable from infantile paralysis, as we see it in children, by inoculation with an emulsion of the spinal cord of patients dying of the disease. The virus was found to be a filter-passer, and to survive preservation in glycerine for many months. In 1912 Kling, of Stockholm, succeeded in recovering the virus from washings from the mouth, nose, trachea and small intestine of fatal cases of infantile paralysis. But the actual microbe causing the disease remained unknown until 1913, when it was isolated, grown on artificial media, and carefully described by Flexner and Noguchi. The success of these investigators where so many others had failed is to be attributed to their discovery of a suitable culture medium. Growths were made anærobically under a layer of paraffin, in a solid agar medium containing sterile unfiltered ascitic fluid, or brain extract and sterile rabbit kidney. Minute colonies of the virus were obtained, composed of globular or globoid bodies averaging in young cultures 0.15 to 0.30 μ in size, arranged singly or in short chains or masses. Third generation cultures from human tissues, and cultures in the fifth generation from the tissues of experimentally infected monkeys, were found to produce typical acute anterior poliomyelitis in experimental animals.

At the present time, therefore, we are in the possession of a good deal of positive knowledge with regard to the pathogenesis and epidemiology of infantile paralysis. The virus producing the disease has been isolated, cultivated and employed for the transmission of the disease to experimental animals in investigations that have proved invaluable and indispensable for the increase of our knowledge of its spread among human beings. The virus has been found in the naso-pharynx of human carriers of the disorder, who though they have never apparently suffered from it

themselves, yet are capable of transmitting it to others. The virus has also been found in the alimentary tract of patients and experimental animals with infantile paralysis, a fact which may explain why it is that a gastro-intestinal upset sometimes precedes and appears to be the cause of an attack of infantile paralysis. The virus has been proved to reach the patient's central nervous system, in which its main pathological action is exerted, by travelling along peripheral nerves—the sciatic, the nasal nerves, the optic nerves and tracts, for example—to the spinal cord or brain as the case may be, and this is to be regarded as the normal mode of infection in poliomyelitis; gross infection of the blood stream with the virus may also suffice to infect the brain. Evidence has been adduced to show that certain flies, particularly *Stomoxys calcitrans,* the common stable fly, may act as carriers of the disease. In addition the virus has been found on clothes, handkerchiefs and toys used by patients in the acute stages of infantile paralysis. The careful examination of washings from the mouth or intestine have shown that human beings may remain carriers of the virus for as long as six months. According to Kling, quarantine for infantile paralysis should last at least a fortnight—in New York it now lasts for ten days or thereabouts, we are told—though it is clear that no certainty attaches to any fixed period in this connection. There is reason to believe that the great majority of adults and many children may be infected with the virus without being a penny the worse for it, either because the virus is enfeebled or because the resistance of such individuals is high. Thus it is probable that every patient actually ill with the disease has in his immediate environment a number of mild and abortive cases of infantile paralysis that escape observation or detection and diagnosis, and also a still larger number of perfectly healthy people who are all carriers of the infecting agent and therefore potential sources of infection to others. It would seem as if all these persons developed a relatively high degree of immunity to the virus, a fact which may explain the comparative immunity of European towns or villages visited by epidemics of infantile paralysis to the occurrence of further epidemics during the next few years. In fact, as with cerebrospinal meningitis, the number of the carriers of the infection may be much larger in infantile paralysis than the number of the victims of an epidemic of that disease.—*The British Medical Journal.*

NOTES ON METEOROLOGY AND CLIMATOLOGY

THUNDERSTORMS OF THE UNITED STATES

A thorough study of the distribution of thunderstorms has been made by Mr. W. H. Alexander with the aid of the officials in charge of more than one hundred of the regular weather bureau stations.[1] Following this, Professor R. DeC. Ward has fittingly brought out the significance of the thunderstorm as a climatic phenomenon.[2]

Thunderstorms are produced (1) by the excessive heating of the lower air; (2) by the over- and under-running of winds of different temperatures, which in some way cause moist air masses to rise rapidly; and (3) by the cooling of the upper air. These causes usually are not individually responsible for any thunderstorm; but act in conjunction.[3] Excessive heating of the lower air occurs in summer and most favorably on plains, plateaus and intermont basins. Thus in the United States the maximum number of thunderstorms is to be expected in the Mississippi Valley, and in the western mountain and plateau region. Furthermore, most come in summer: in 126 of 139 stations considered[4] the month with most thunderstorms is June, July or August. Cyclonic activity in a region subject to marked temperature changes is usually responsible for the production of thunderstorms by over-run-

[1] *Mo. Weather Rev.,* July, 1915, pp. 324–340, 13 maps.

[2] Pan-American Scientific Congress; abstract in *Mo. Weather Rev.,* December, 1915, p. 612.

[3] A comprehensive investigation of the physics of the thunderstorm was published in 1914 by Professor W. J. Humphreys. See review in Science, December 4, 1914, p. 823.

[4] H. Lyman, "Percentage Frequency of Thunderstorms in the United States," *Mo. Weather Rev.,* December, 1915, pp. 619–620.

ning and under-running winds. This leads to the winter and spring thunderstorms; particularly in the southern Mississippi Valley where the lower air is warmest and dampest. The cooling of the upper air while the lower remains relatively warm is characteristic of a marine location. With the aid of cyclones, thunderstorms produced in this way are to be expected in winter and at night. The Pacific coast region thus tends to have its thunderstorms, few at most, in winter.

For illustration, the accompanying table shows the monthly percentage frequencies of days with thunderstorms at seven stations in the United States.[4] A thunderstorm day is now defined as one on which thunder is heard whether or not rain falls at the observing station.

Station	Per Cents. of Ten-year Total Occurring in Each Month												Total Thunderstorms, 1904–1913
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
San Francisco, Cal.	12	50	12	0	0	0	0	0	0	13	0	13	8
Fresno, Cal.	3	14	16	14	16	5	3	0	11	8	5	5	37
Boston, Mass.	2	1	4	4	14	17	23	22	11	2	2	1	180
New York, N. Y.	1	1	3	9	14	18	25	19	9	3	0	0	284
Chicago, Ill.	2	1	6	8	15	16	17	16	12	4	2	0	400
Santa Fé, N. Mex.	0	1	3	4	9	15	29	24	12	3	0	0	732
Tampa, Fla.	1	2	3	3	10	17	24	22	14	3	0	1	944

At San Francisco, atmospheric instability does not often occur in summer. Fresno has its maximum early probably because the air is too dry in mid-summer. The other stations have the greatest number in summer. Boston, New York and Chicago all have an abundance of moisture. The greater number of thunderstorms in Chicago for the year, and particularly in spring, as compared with New York and Boston, is due to its continental position and exposure to rapid temperature changes. The interior location favors more rapid warming in spring than is the case in the east. Even New York appears markedly more continental than Boston. It is noteworthy that there are more thunderstorms in May than in September: May is moister; and the upper air is colder. The great thunderstorm activity at Santa Fé is favored by the mountain location (altitude 7,013 feet) east of the Rio Grande. In June, July and August there is, on the average, a thunderstorm every other day. Thunderstorms are less than half as frequent at the drier, lower places such as El Paso. Tampa has more thunderstorms than any other weather bureau station in the United States. In the three summer months, thunderstorms occur on about two days out of three. The summer on-shore winds supply abundant moisture and the intense sunlight at this low latitude effectively overheats the lower air. Thus the joint distribution of atmospheric instability and moisture dominate thunderstorm frequency.

Parts of Professor Ward's abstract are quoted here:

"As essential characteristics of American climate, thunderstorms have a broad human interest. From the viewpoint of climatology, the distribution of thunderstorms is of more interest than their mechanism. The part played by their rains in watering our crops is of greater importance than the size of the raindrops. The damage done by their lightning[5] and hail[6] concerns us more than the cause of the lightning flash or than the origin of the hailstorms. The thunderstorms of the eastern United States are among the most characteristic of American climatic phenomena. In size, intensity and frequency of occurrence they are unique.

"In relation to man's activities, it is of significance that most thunderstorms occur at a time of year and at the hours when outdoor activities are at their height.

"Thunderstorms bring us much that is of benefit. To them we owe much, in parts of our country even most, of our spring and summer rainfall. Without these beneficent thunderstorms our great staple crops east of the Rocky Mountains would never reach maturity. One good thunderstorm over a considerable area at a critical crop stage is worth hundreds of thousands of dollars to American farmers. Our stock markets time and again

[5] See note on "Thunder and Lightning," SCIENCE, N. S., Vol. XLII., 1915, p. 252.

[6] See note on "Hail," below.

show the favorable reaction of such conditions upon the prices of cereals and also of railroad and other stocks. Thundershowers break our summer droughts, cleanse our dusty air, refresh our parched earth, replenish our failing streams and brooks, bring us cool evenings and nights after sultry and oppressive days."

HAIL

Hail consists of particles of ice from the size of peas to that of oranges or larger which fall from the clouds. True hail, which is usually a summer phenomenon, and is characterized generally by a central core of cloudy ice surrounded by one or more layers of clear ice, should not be confused with the small ice pellets of winter. Hail rarely occurs without a thunderstorm, of which hail may be said to be a violent manifestation. Thus the distribution of hail is limited, and patchy, falling sometimes on parallel strips of land in the same thunderstorm. As hail is an accompaniment of thunderstorms, it occurs in the warm southeast quadrant of a cyclone, or associated with the over- and under-running winds on a wind-shift line. For example, the passage of a wind-shift line over the region from Illinois to Maryland, June 20 to 22, 1915, was accompanied locally by very large hail: "teacups" in Illinois and "baseballs" in Maryland.[7] The annual and diurnal periods of hail occurrence are much the same as those of thunderstorms, although more marked. Thus, in the United States, the month with most hail is May, and the time of day, mid-afternoon; while least hail falls in winter and in the early morning. In distribution over the earth, there is least hail in the polar regions where the air seldom has sufficient moisture or is sufficiently unstable to satisfy hail requirements. On the other hand, near the equator at sea-level hail rarely occurs because the freezing level is too high and the lower air too warm to permit hailstones to reach the earth's surface. Hail may fall on the ocean with the passage of a wind-shift line. Its greatest development comes in the subtropical deserts: there the most frightful hailstorms occur—storms in which men and beasts not killed outright may be frozen to death under the hail.

The annual and diurnal periods and the local distribution just mentioned are easily explained as follows: the moister and the warmer the lower air, and the colder the upper air, the faster and the farther will the warm air rise; and the greater is the opportunity for hail formation. The moisture comes from the lower air, the cold from the expansion of this air on rising. For instance, a mass of air at 30° C. and with a relative humidity of 50 per cent. will reach 0° at 4.8 kilometers, and —20° at 7.9 kilometers' altitude, mixing being disregarded. Hail clouds frequently tower 8 or 10 kilometers above the earth's surface. Apparently, hail originates when snow crystals begin to form among raindrops, which are usually carried up into the level where the temperature is below freezing. A snow-flake and an undercooled drop freeze together into the opaque ice that forms the core of a hailstone. As this ice particle falls through the layer of undercooled raindrops, which may be 3 to 4 kilometers thick, a layer of ice is added. Then it may be caught in one of the tornadic whirls, which evidently occur within thunderstorms, and carried aloft. On being released, perhaps near the top of the cloud, it may accumulate another layer of ice on the way down. This cycle may be repeated many times. Finally, when too heavy to be held in the uprushing currents, or when the whirl collapses, the hail, congealing moisture on its cold surface as it falls, may descend to earth. For example, some of the larger hailstones, 3 to 4 inches in diameter, falling in Annapolis, June 22, 1915, had 20 to 25 layers of ice. The hail was of diverse shapes.[8] That hail must return to the upper part of the cloud after having grown to a considerable size is evident from the temperatures of —5 to —15° C. observed in hailstones. Hail does not occur in spite of hot weather, but because of the heat.[9]

[7] See O. L. Fassig, *Monthly Weather Rev.*, September, 1915, pp. 446–448; and "Climatological Data for the United States by Sections," Vol. 2, June, 1915, Illinois, Indiana, West Virginia and Maryland sections.

[8] See Fassig, *ibid.*

Hail damage is both local and occasional. In some countries, particularly in France, reliance is placed in cannon, rockets or lightning rods to protect crops from hail. Professor Angot, head of the French Meteorological Service, stigmatized these as useless. For example, "the Observatoire de Bordeaux, situated in Floirac . . . was . . . provided with a 'niagara' (lightning rod) September 22, 1912. The commune of Floirac was devastated by hail on August 15, 1887; but for the succeeding 25 years it had been immune. Again in 1912, two disastrous falls of hail occurred at Floirac, one on July 5, before the installation of the 'niagara,' the second on October 20, when a heavy shower of very large hard hailstones fell upon the 'niagara' itself during a period of $2\frac{1}{2}$ minutes."[10] Hail insurance, however, is the usual mode of protection. Insurance companies are without adequate means for fixing the premiums because the average occurrence of hail can hardly be mapped without an excessive number of stations and a very long period of observations. Hail damage is at times extreme. For instance, in South Carolina, July 6 to 7, 1914, crop losses estimated at $955,000 were sustained over an area of about 50,000 acres of crop land. The damage was done mostly by immense quantities of hailstones the size of ordinary marbles.[11] Hail at times destroys live stock also. Thus in Illinois on June 20, 1915, 50 shoats, some sheep and cattle were reported to have been killed by hail. The skulls and backs of some of the hogs were said to have been broken.[12] In cities, skylights, windows and greenhouses sustain the most damage. Plate glass even 1 to 2 centimeters thick may be shattered. Horses frequently and people occasionally are injured.

[9] The material for the summary above, except as specified in foot-notes 7 and 8, was taken from J. von Hann's "Lehrbuch der Meteorologie," Leipzig, 1915, pp. 708–725.

[10] See translation, *Monthly Weather Rev.*, March, 1914, p. 166.

[11] "Climatological Data: South Carolina Section," Vol. 1, July, 1914, p. 56.

[12] "Climatological Data: Illinois Section," Vol. 2, June, 1915, p. 43.

Damage by other features of thunderstorms such as the squall and lightning, is, in general, much greater than the occasional hail destruction. Nevertheless, hail can destroy crops as completely as a tornado or a flood.

R. H. SCOTT, 1833–1916

One of the pioneers in synoptic meteorology, Dr. R. H. Scott, died in England, June 18. He was well known as the chief of staff of the Meteorological Office from the formation of the Royal Society's Meteorological Committee in 1867 until his retirement on a pension in 1900. He was also secretary of the International Meteorological Committee from its commencement in 1874, until 1900. In 1861, Fitzroy had begun the issue of forecasts and storm warnings, based on information collected daily by telegraph and charted on maps. The issue of forecasts and storm warnings was suppressed; but at the request of the board of trade the issue of storm warnings was at once revived. The telegraphic service was developed, and the first result of Scott's work appeared in 1876 in a little book, entitled "Weather Charts and Storm Warnings." The issue of forecasts was recommenced on April 1, 1879, and has continued ever since. This was followed in 1883 by Scott's "Elementary Meteorology," which took foremost place as a text-book of meteorology. From that time onward Scott devoted his attention mainly to the administration of the office and to the work of the Meteorological Society.[13]

ALEKSANDR IVANOVICH VOEIKOV, 1842–1916

Voeikov (Woeikow), the eminent meteorologist and geographer, died in Petrograd, January 28 (February 10), 1916. He was born in Moscow, and while still young traveled widely in Europe, Asia and the two Americas. In 1884 he published his great work, "The Climates of the World" (German translation, 1887). The following year he was appointed professor of physical geography at the Univer-

[13] From W. N. Shaw, *Nature*, London, Vol. XCVII., 1916, p. 365. A history of British weather forecasting and an account of the organization and work of the Meteorological Office in London is published in the *Monthly Weather Rev.*, September, 1915, pp. 449–452.

sity of St. Petersburg, and later, director of the meteorological observatory there. His meteorological work which was very comprehensive centered most, perhaps, on the relations between the temperatures of air, ground, oceans and lakes. In 1904, Voeikov published "Meteorologia," a handbook of 719 pages in Russian, and at present the leading meteorological text in that language. As a geographer, he is noted particularly for his publications on the rôle of the Pacific Ocean in the world's affairs, an article on the regeneration of Russia, and a French work "Le Turkestan russe."[14]

NOTES

Prince Boris Borisovitch Galitzine died at Petrograd, after a short illness, on May 4 (17), of this year, at the age of 54 years. For the past three years he was director of the meteorological service of the Russian Empire. He is best known for his distinguished work in seismology.[15]

Sir William Ramsay, "the father of the new physical chemistry," and England's foremost chemist, died July 24, 1916. His contribution to meteorology, conjointly with Lord Rayleigh, was the discovery of the four noble atmospheric gases: argon, neon, krypton and xenon. Nitrogen derived from air was found to be denser than that obtained from other sources. By heating atmospheric nitrogen repeatedly with metallic magnesium Ramsay obtained a denser and denser gas which proved to be quite different from nitrogen. At the same time, Lord Rayleigh was able to separate nitrogen from possible impurities by repeating with modern apparatus an experiment devised by Cavendish. These two investigators continuing jointly discovered argon, first of a new class of elements. Incidental experimenting with liquid air led to the discovery of three other elements of this same type—neon, krypton and xenon.[16]

[14] See *Monthly Weather Rev.*, May, 1916, pp. 288–289.

[15] See *Nature, London,* Vol. XCVII., 1916, p. 424.

[16] *Scientific American*, August 5, 1916, p. 117.

Early this year Dr. Th. Hesselberg became director of L'Institut meteorologique de Norvege, Kristiania.

German meteorological magazines dated February, 1915, seem to have been the last ones received in this country.

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SPECIAL ARTICLES

THE BROMINE CONTENT OF PUGET SOUND NEREOCYSTIS (GIANT KELP)

It seems strange indeed that scarcely any mention is made in the American technical literature of the presence of bromine in the seaweeds of the Pacific coast, especially those seaweeds which have been termed "kelp." Available analytical data on the quantities of bromine from the above source is negligible.

The writer considers this to be due to one or more of several possible reasons. Perhaps, if bromine has been previously detected, it was not considered to be present in quantities large enough to be of importance. The content of bromine must vary considerably in amount in the various varieties and species of seaweeds. Either it does not occur in certain species or varieties, or the same variety from different localities contains it in widely different proportions. Again, the difficulty met with in determining bromine quantitatively in the presence of an excess of the other haloid salts is a contending factor in the production of analytical data upon this subject.

A personal experience, which attracted my attention to the bromine content of seaweed, may prove interesting at this point. Some two years ago, while teaching chemistry in the College of Puget Sound, Tacoma, Wash., it was my privilege to often walk along the beach at The Narrows, especially during the time of low tide. The Narrows is situated about four miles west of the city of Tacoma, and borders the mainland on the west and a strip of beach, known as Day Island, on the east. The channel of the sound is less than a half-mile wide

at this place and hence receives the full wash of the Sound's waters from each tide. The numerous quantities of igneous rocks in the channel and the rapidly moving water makes this location an ideal "field" for the growing of *Nereocystis luetkeana*. At low tide the beach is strewn with seaweed along with a few other, but smaller, varieties.

The stems and leaves are covered with a slimy coating from one sixteenth to one eighth of an inch in depth, and composed of algæ and other microorganisms. This covering acts as a protective coating to the seaweed while it lies exposed to the sun's radiations during low tide. Many of the leaves, twelve to twenty feet long and sixteen to twenty inches in width, develop light yellow spots with a filmy texture sometimes covering large portions of the leaves. The chlorophyl disappears entirely from these spots and does not apparently reappear as such upon submergence during the incoming tide. Upon close examination it is found that the slimy covering mentioned above has dried completely over the bleached spots, and in many instances there is none of the dried film present, suggesting that the slimy covering had been removed mechanically by wave motion, etc.

One would be at a loss to explain this discoloration of green coloring-matter in the seaweeds was it not for the strong odor of bromine in the vicinity where this bleaching was in progress, especially after the sun had radiated upon the beached plants for an hour or more. The "stench" of the fumes as being due to bromine is unmistakable to those who are at all familiar with the element. The presence of the bromine in the air about these localities must be due to the action of photo-chemical or microorganic processes upon the combined bromine and other halogens present in the seaweed. The liberation of small amounts of the halogens in the presence of the chlorophyl undoubtedly causes its discoloration.

In order that it might be determined whether or not the bromine existed in combination within the seaweed, several large *Nereocystis* (stems and leaves intact) were secured, washed, dried and ashed. The ashes gave a strong test for both bromine and iodine.

From the qualitative test one would expect the quantity of bromine to be equal to, if not greater than, the iodine content in the same ash. The ashes from *Nereocystis* secured at different times were kept on hand and given to the students for analytical determinations, viz., sodium, potassium, chlorine, bromine and iodine.

Two large *Nereocystis luetkeana* yielded upon quantitative examination the following substances expressed in per cent. of dry weight of material:

	K_2O, Per Cent.	I, Per Cent.	Br, Per Cent.
No. 1	22.3	0.30	0.19
No. 2	24.7	0.23	0.11

Though not going into detail as to the methods used in analysis (a detailed analysis will be reported in one of the chemical journals) I might say that standard procedures were followed.

It appears that the bromine should be both recoverable and merchantable in view of the present prices of this commodity.

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THE NORTH CAROLINA ACADEMY OF SCIENCE

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE North Carolina Academy of Science met in annual session at the Agricultural and Mechanical College, Raleigh, on Friday and Saturday, April 28 and 29, 1916. The executive committee had a meeting on Friday afternoon, and after this there was a session for the reading of papers. At night President D. H. Hill, of the college, delivered an address of welcome and then President A. S. Wheeler, of the academy, gave his presidential address, "The Critical Dyestuff Situation," with a demonstration of materials. Next Professor E. W. Gudger read a paper entitled, "The Remora or Echeneis; A Living Fish-hook," illustrated with specimens and photographs.

On Saturday morning at 9 the annual business meeting of the academy was held. The secretary-treasurer made his report, which showed the finances of the academy to be in good condition with a comfortable balance in savings bank. The various stated committees made their reports. An invitation to hold the 1917 meeting at the University of North Carolina, at Chapel Hill, was accepted. Twenty-three new members were elected and two former members reinstated, bringing the total membership up to 88.

The following officers were elected for 1916–17.

President—F. P. Venable, University of North Carolina, Chapel Hill.

Vice-president—H. C. Beardslee, Asheville School for Boys, Asheville.

Secretary-treasurer—E. W. Gudger, State Normal College, Greensboro.

Additional members executive committee—J. E. Smith, University of North Carolina, Chapel Hill; E. O. Randolph, Elon College; Bert Cunningham, City High School, Durham.

At the close of the business session a joint meeting was held of the academy and of the North Carolina Section of the American Chemical Society, at which papers of interest to both bodies were read. Following these the chemists and the academy held separate meetings to complete the reading of papers on their respective programs. The academy adjourned at 1:30 P.M. The total attendance was 43 out of a membership of 86. There were 23 papers on the program, of which only 3 were read by title. Including the presidential address, which will be published in the current number of the *Journal of the Elisha Mitchell Scientific Society*, the following papers were presented:

Observed Changes in the Land Vertebrate Fauna of North Carolina: C. S. Brimley.

Notes the known changes in the abundance and distribution of certain birds, mammals and reptiles in North Carolina. The full paper is published in the current number of the *Mitchell Journal.*

Two Raleigh Amblystomas: C. S. Brimley.

Compares briefly the species of *Amblystoma* occurring at Raleigh, *A. opacum* and *A. punctatum.*

The data for these is given in full in the proceedings published in the *Mitchell Journal.*

Aristotle's Echeneis not a Sucking-Fish: E. W. Gudger.

The identity of this fish was discussed and data presented to show that it was a goby, while evidence was adduced that the "dolphin's louse," elsewhere referred to by Aristotle in his *History of Animals*, was a sucking-fish.

The Echeneis or Remora; a Living Fish-hook: E. W. Gudger.

The tendency of this fish to adhere to turtles, sharks or any large fish by means of its cephalic sucking disk, is made use of in many parts of the world to render easy the catching of fish. A thin cord is tied around the "small" of the tail of the fish and it is set free in the water. Finding a turtle or fish, the fisherman-fish clamps itself fast to it, and both are hauled in by the fisherman. This use of the living fish-hook was traced back to 1494, when Columbus (the first European to see it so used) witnessed its exploits on the south side of Cuba on his second voyage. The paper was illustrated by numerous photographs of illustrations in old books, showing this use of the fish. The completed paper will be published later.

Some Interesting Mushrooms: W. C. Coker.

Several species new or rare in North Carolina were shown, with photographs and paintings.

Naucoria sp. A species of this genus, not recorded from this state, has appeared in manured soil in the arboretum of the university for several years. It is of good size and very resistant to decay, and was tested and found harmless, and if the bitter gills are removed makes a very pleasant dish. As it appears very early in the season, during April, and before other species of any size are out, it is a valuable addition to our list of edibles. The species seems nearest *N. hamadryas*, but differs from it in some respects.

Clavaria spiculispora Atkinson. A painting of this species was shown. It was described from our collections of Chapel Hill plants. It is remarkable for the very deep brown color (deepest of any other American Clavaria), and the very long spicules on the spores. We have since found it in the mountains near Black Mountain. It is not known except from this state.

Amanita chlorinosma Pk. Photographs and paintings were shown to illustrate the great range in size and color of this species. White, greenish, salmon, reddish and ashy-brown forms occur. All the forms have a distinct odor of chlorine.

Nyctalis asterophora Fr. A photo was shown of this plant growing on *Russula nigricans.* It is very peculiar in having another mushroom for its host, and in the degenerated gills. The functional spores are not borne on the gills as usual, but on the cap as a fine powder, and are very large and irregular.

Venereal Infections in Animals: G. A. ROBERTS.

Observations, investigations and reports indicate very wide-spread venereal infections in this country and abroad among domestic animals, horses, cattle, sheep, swine, etc. Such infections have been known to exist in the human family for a long time.

Few people have recognized the extent and manifold results of these infections.

The most extensive investigations and the greatest losses, direct and indirect, in animals have been among dairy cattle and breeding herds.

The specific organism responsible for the infections in cattle has all but universally been accepted as the *Bacillus abortus* (Bang). Many cases of infection with the *B. abortus* are too mild to produce clinical symptoms. The results observed in many such infections, however, are: abortions, including premature births, still births and births of weaklings; metritis (inflammation of the uterus); and sterilities, temporary and permanent.

Retained "after-birth" is quite common in cattle when expulsion of the fetus occurs during the latter half of pregnancy, owing to the peculiar attachment between the fetal membrane and the uterus at the time.

Nymphomania is not uncommon in cows and mares.

The relation of this organism to certain udder diseases and the granular venereal disease of cattle, to some forms of calf scours and infant diarrheal troubles, has not been determined, but is suspicious of a close relationship.

Resistance and Immunity in Plants: F. A. WOLF.

This paper contains a brief summary of the facts which have been correlated with resistance and immunity in plants in attempts to explain the underlying causes. Attention is called to several investigations dealing with morphological differences between susceptible and immune varieties. Consideration is also given to the influence of mineral nutrients in the soil upon resistance. The discussion also includes those causes which reside within the protoplasm of the host plants such as differences in acidity, tannin content, etc., of susceptible and immune varieties. It is believed that too little attention has heretofore been given to the inherent characters of the parasitic organism which determine the virulence of the parasite.

Some Methods of Making Lantern Slides: Z. P. METCALF.

The need of some form of projection in science teaching and the general utility of lantern slides was emphasized. Two methods of making lantern slides were discussed and examples of various kinds of lantern slides were shown.

Trees and Shrubs of Chapel Hill: H. R. TOTTEN.

There are seventy-two species of native trees found in the Chapel Hill neighborhood. In this number there are fourteen oaks: *Quercus alba* L., *Q. stellata* Wang., *Q. lyrata* Walt., *Q. Michauxii* Nutt., *Q. prinus* L., *Q. ruba* L., *Q. palustris* Muench., *Q. velutina* Lam., *Q. falcata* Michx., *Q. pagodaefolia* (Ell.) Ashe, *Q. marilandica* Muench., *Q. nigra* L., *Q. phellos* L. A hybrid, probably between *Q. phellos* L. and *Q. falcata* Michx., is also found. This is the only station for the Pin Oak (*Q. palustris*) in North Carolina. There are seven hickories: *Hicoria ovata* (Mill.) Britton, *H. carolina-septentrionalis* Ashe, *H. microcarpa* (Nutt.) Britton, *H. glabra* (Mill.) Britton, *H. pallida* Ashe, *H. alba* (L.) Britton, and *H. cordiformis* (Wang.) Britton.

There are sixty native shrubs. A few of the most interesting are: *Nestronia umbellata* Raf., *Hydrangea arborescens* L., *Euonymus atropurpureus* Jacq., *Ascyrum stans* Michx., *Rhododendron catawbiense* Michx., *Fothergilla major* Lodd., *Robinia nanna* (Ell.) Spach., *Gaultheria procumbens* L., *Gaylussacia baccata* var. *glaucocarpa* (Robinson) Mackenzie, and *Symplocos tinctoria* (L.) L'Her.

On the Sexuality of the Filament of Spirogyra: BERT CUNNINGHAM.

If zygotes occur in both filaments as the result of scalariform conjugation, the filament is said to be bisexual. This condition is called cross conjugation. All cases reported thus far have been considered as abnormalities on account of their rareness. The writer collected a species in cross conjugation in April, 1915. It has been tentatively identified as *S. inflata*. Professor G. S. West verifies this classification. This shows that bisexuality of the filament does occur in the genus. Bisexuality is due to retarded reduction. In scalariform conjugation reduction occurs in the zygote with the loss of three nuclei, while in lateral and cross conjugation, reduction takes place in the filament and no nuclei are lost. The essential difference between lateral and cross conjugation is that the cells may continue to divide after reduction in the latter, while they do not in the former. In this respect the filament of *Spirogyra* which cross conjugates is homologous with the sporophyte of higher plants.

The Diorites of the Chapel Hill Stock: JOHN E. SMITH.

The specimens described here were obtained along Bolin's Creek. Some were taken near the inner margin of the zone and some near the creek at the foot of Clover Hill. The primary minerals as shown by the microscope are oligoclase, hornblende, quartz, magnetite and apatite named in order of their abundance. The apatite occurs as inclusions. The oligoclase contains innumerable, minute inclusions occupying most of the area of the crystals except in the narrow marginal zone which are entirely free from them. The parallel striations are in general very narrow and very close together and in some of the zones are invisible. The order of crystallization is as follows: apatite, magnetite, hornblende, oligoclase and quartz. The secondary minerals are epidote, and a small quantity of albite. They are derived from the oligoclase, magnetite and hornblende by hydration.

The quartz decreases in amount outward from the center of the stock. The lime in the water supply of Chapel Hill is produced from this feldspar. The soils derived from the rocks of this zone constitute the Iredell series and contain little or no potash.

Physiography of the Isle of Palms (S. C.): E. OSCAR RANDOLPH.

The Isle of Palms, situated eight miles to the northeast of Charleston, and connected with that city by a trolley line, has an area of approximately 4,000 acres. This sea-captured land is about six and one fourth miles in length, and one and one fourth miles in maximum width, tapering to a decided point at the southwestern end. Physiographically this area is interesting and instructive. In shape it approximates a ham; and by local fishermen it is called "the ham."

From the mainland the island is separated by a narrow inlet that is wide and deep enough to convey local freight-, pleasure- and fishing-vessels. This back beach is subjected to no unusual geological agencies except tidal work. The front beach is subjected to wave, tidal, wind and littoral current agencies. As a result, frequent shoreline configurations are effected. The writer made a number of instructive observations relative to immediate changes of epicontinental shelving between the points of high and low tide respectively.

Two well-defined sand dune ridges traverse the island lengthwise. Physiographically, incipient, migratory, temporary and fixed dunes are in evidence. Among the flora are found sand arresters and dune fixers. The front beach is continuously attacked by wind and wave action; the interdune area is likewise undergoing change under the influence of wind-trough currents and animal life. The age and stability of the fixed dunes, ranging in height from twenty-five to forty feet, is realized in their supporting luxuriant palm trees.

Alternation and Parthenogenesis in Padina: JAMES J. WOLFE.

At the meeting of this academy in 1913, the writer made a preliminary report on this work. It had then been carried only to the point of demonstrating that tetraspores invariably produce male and female plants. The entire series has now been completed, showing with equal certainty that fertilized eggs produce only tetrasporic plants—thus demonstrating "alternation of generations" in *Padina*.

In view of the fact that *Padina* grows well only in localities where it normally occurs, in the experiments dealing with parthenogenesis, clean oyster shells were attached alongside those bearing unfertilized eggs to serve as controls. The results of both series were in essential respects sufficiently similar to show that all plants recovered were in both cases derived from chance reproductive bodies. Thus, it is fairly conclusively shown that unfertilized eggs, though they germinate quite freely parthenogenetically, never produce mature plants.

No abstracts have been received for the following papers:

"Friday Noon," by George W. Lay.

"Zonation in the Chapel Hill Stock," by Collier Cobb.

"*Russula xerampelina;* a Study in Variation," by H. C. Beardsley.

"Improvements in the Method of Determining the Heating Value of a Gas," by C. W. Edwards. (By title.)

"Magnetic Separation of Minerals," by Joseph Hyde Pratt.

"Insect Polyembryony," by R. W. Leiby. (Lantern.)

"An Apparatus to Illustrate the Cohesion of Water—with Reference to the Ascent of Sap," by F. E. Carruth. (By title.)

"Some Recent Feeding Experiments with Cottonseed Products," by W. A. Withers and F. E. Carruth. (By title.)

"A Study of Some Nitrifying Solutions," by W. A. Withers, H. L. Cox, F. A. Wolf and E. E. Stanford. (By title.)

"A New Industry for North Carolina," by C. P. Williams. (By invitation.)

E. W. GUDGER,
Secretary